

COLLEGE

Biology

PBA^{11&12}

PRACTICAL BASED ASSESSMENT HSSC (COMPOSITE)

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WORKBOOK



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PREFACE

This biology practical workbook has been written for HSSC students in accordance with the Federal Board recent Practical Based Assessment (PBA) theme. It covers the entire syllabus and, in addition, different approaches to practical has been given as is required by PBA assessment scheme.

The subject matter throughout the book has been written in a simple, precise and comprehensive form. The book has two distinct sections

- **Section-A** deals with practical and analytical based experiments which has 60% (18 marks) weightage in paper.
- **Section-B** deals with various kingdoms involving identifications, life cycles and functions which has 40% (12 marks) weightage in paper.

All the experiments have been discussed and elaborated to such an extent that no further reading is needed on practical aspect of the syllabus. At the end of each practical, practical Based Assessment (PBA) worksheets have been given which will enable students to evaluate their learning and will prepare them for Federal Board PBA examination. The solution to worksheet problems is also provided. Complete solved model papers have also been given. Furthermore, important short questions and calculations are also given.

The author will welcome comments and suggestions to improve the standard of this practical workbook.

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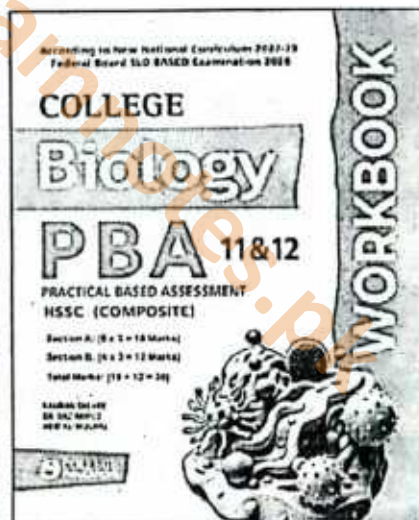
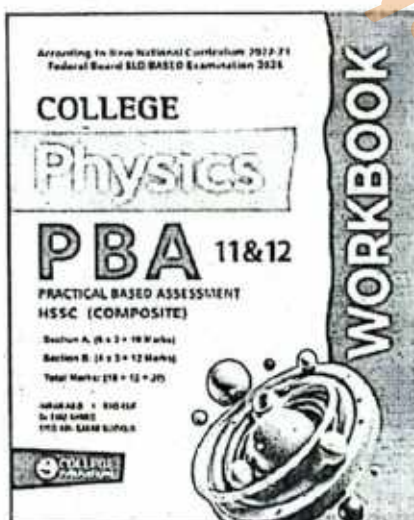
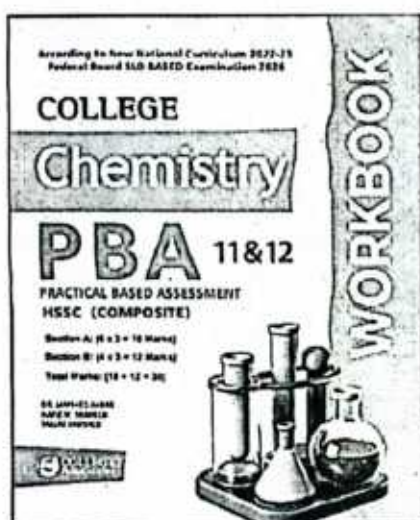
- i. The paper will consist of two sections i.e section A and B.
- ii. Section A will include Major Practicals. This section will have three questions, each question carrying 6 marks having parts in it, and each question will be performance / calculation/procedures/observations based encompassing a single practical.
- iii. Section B will include Minor Practicals. This section will also have three questions, each carrying 4 marks having parts in it. Each question may be based on single or multiple practicals.
- iv. The weightage of section A will be 60% i.e 18 marks, while that of section B will be 40 % i.e 12 marks.
- v. In Practical Based Assessment (PBA), there is no marks for practical notebooks. But students are suggested to record procedures, observations, apparatus and calculation etc on any type of plain papers/work sheets / practical folders for their future memory of all aspects of practical performance in order to attempt the PBA Examination amicably.
- vi. It may be noted that performance of all the prescribed practicals is mandatory in the laboratory during the whole academic session because only those students will be able to attempt the PBA who have performed the practicals in the laboratory as per requirement of each practical.
- vii. MCQs will not be included/assessed in the Practical Based Assessment paper.
- viii. Questions carrying 0.5 marks will not be included/assessed as single part in any section of the PBA paper.

SECTION A

60% of Practical Marks

18 Marks

MAJOR PRACTICALS



EXPERIMENT

1

STUDY OF EFFECT OF TEMPERATURE ON THE RATE OF ENZYME ACTIVITY OR RATE OF REACTION.

(A) STUDY OF EFFECT OF TEMPERATURE ON THE RATE OF ENZYME ACTIVITY OR RATE OF REACTION

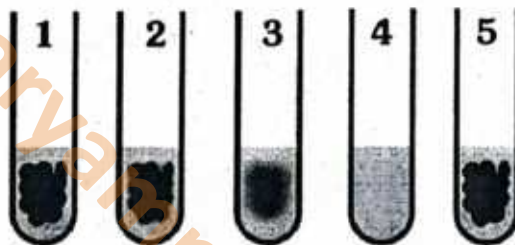
The rate of enzyme action increases with the increase of temperature. The reaction rate is doubled after every rise of 10°C in temperature. But very high temperature denatures the enzyme. Therefore, rate of reaction is decreased at high temperature.

APPARATUS:

- 5 test tubes
- Water bath
- Tripod stands.
- Incubator / water baths
- Test tube rack
- Bunsen burners
- 1% pepsin solution
- Pepsin
- Thermometers
- HCl (conc)
- Petri dish
- Toluene
- Egg

PROCEDURE:

- Get egg white (Albumin) of a boiled egg.
- Now cut it into five squares of 1 mm.
- Now put each square in each of five test tubes
- 15 ml pepsin and 10 drops of 0.1 Molar solution of HCl are added in these test tubes.
- Two drops of toluene are added in each tube to retard bacterial growth.
- These tubes are put in separate five incubators/water baths to maintain the temperature up to 10°C , 20°C , 30°C , 37°C , and 50°C .



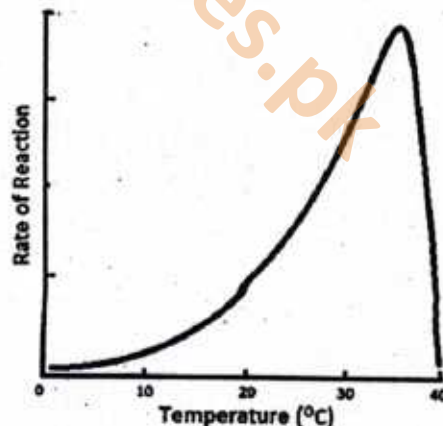
OBSERVATIONS:

Observe the test tubes from the incubator/water bath after 1 hour

Test tube	Temperature	Result of the test/conclusion
1	10°C	No digestion
2	20°C	Slight digestion (20-40%)
3	30°C	80% digestion
4	37°C	100% digestion
5	50°C	No digestion

CONCLUSION/RESULT:

Above data show that the rate of action of pepsin increases with the increase of temperature. It is most active at optimum temperature 37°C . But it is denatured and become inactive at 57°C .



(B) STUDY OF EFFECT OF pH LEVELS ON THE RATE OF ENZYME ACTIVITY OR RATE OF REACTION

General concept

The pH directly affects the enzyme activity. Every enzyme has optimum pH. It works efficiently at this pH. Any change in pH causes ionization of enzyme and hence break it. So reaction rate is retarded.

APPARATUS:

- Egg Albumin
- Petri dish
- 5 test tubes
- knife
- Incubator
- 1% pepsin solution
- 0.1 M HCl
- 0.1 M NaOH.

PROCEDURE:

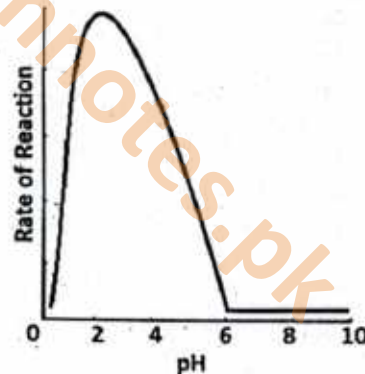
- Get egg white (Albumin) of a boiled egg.
- Now cut it into five squares of 1 mm.
- Now put each square in each of five test tubes.
- 15 ml pepsin and 10 drops of 0.1 Molar solution of HCl are added in these test tubes.
- Now the pH of these tubes is adjusted by following ways as shown in the table:
These tubes are placed in incubator/water bath at 37°C for 1 hour.



Test tube	pH	Acid/base addition	Result of the test/conclusion
1	Alkaline with pH 9	10 drops of 0.1 M NaOH are added	No digestion
2	Slightly alkaline with pH 8	5 drops of 0.1 M NaOH are added	No digestion
3	Neutral with pH 7	10 ml water is added	No digestion
4	Slight acidic with pH 5	5 drops of 0.1 M HCl is added	Partial digestion
5	Acidic with pH 2	10 drops of 0.1 M HCl is added	Complete digestion

RESULT:

The observation shows that pepsin enzyme work in highly acidic condition. Its optimum pH is 2.



(C) STUDY OF EFFECT OF ENZYME CONCENTRATION ON THE RATE OF ENZYME ACTIVITY OR RATE OF REACTION

General concept

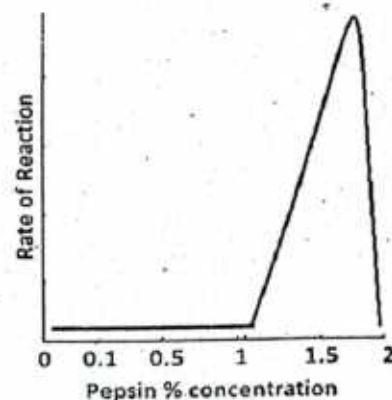
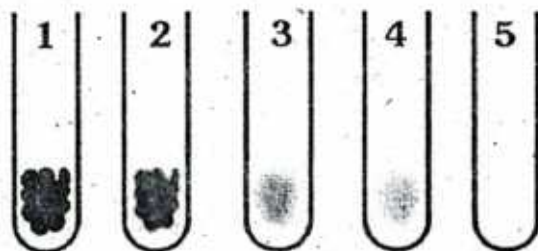
The rate of reaction is increased with the increase of concentration of enzyme. There should be unlimited amount of substrate and temperature should be optimal.

APPARATUS:

- Egg Albumin
- Petri dish
- 5 test tubes
- Knife
- Incubator
- 0.1 M HCl
- 0.1%, 0.5%, 1%, 1.5%, 2.0% pepsin solutions

PROCEDURE:

- Get egg white (Albumin) of a boiled egg.
- Now cut it into five squares of 1 mm.
- Now put each square in each of five test tubes labeled as 1, 2, 3, 4 and 5.
- 15 ml pepsin and 10 drops of 0.1 Molar solution of HCl are added in these test tubes.
- Now 15 ml pepsin is added into each tube with following concentrations as shown in table.
- These tubes are placed in incubator/water bath at 37°C for 1 hour.



OBSERVATIONS:

Test Tube	Pepsin concentration	Conclusion
1	0.1%	Slight/No digestion
2	0.5%	Slight digestion
3	1%	50% digestion
4	1.5%	80% digestion
5	2%	Complete digestion

RESULT:

The observations show that rate of activity of pepsin increases with the increase of enzyme concentration. This rate becomes maximum at 2% concentration of pepsin.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1 Why should toluene be added to the contents of the test tubes?

Ans. The toluene checks the growth of bacteria. If the bacterial growth goes unchecked decomposition of protein will take place instead of its digestion.

Q.2 Why is hydrochloric acid added to the experimental tubes?

Ans. The hydrochloric acid is added so as to make the protein (food) acidic because the enzyme pepsin can act upon the protein only in acidic medium.

Q.3 At what pH is the digestion of protein by pepsin most effective?

Ans: It is most effective at pH 1 to 3.

Q.4 Does pepsin bring about the complete digestion of protein?

Ans: Complete digestion involves conversion of protein into amino acids. Pepsin brings about incomplete digestion of protein by converting it into polypeptides.

Q.5 What is a protein digesting enzyme commonly known as?

Ans: It is commonly known as the proteolytic enzyme (e.g, pepsin, trypsin etc)

Q.6 Where is the enzyme pepsin secreted in the human body and in which form?

Ans: Pepsin is secreted by the gastric glands in the stomach in an inactive form called pepsinogen.

Q.7 How is pepsinogen converted to active pepsin?

Ans: Pepsinogen is converted to the active form pepsin, by the HCl in the gastric juice.

Q.8 What conditions are necessary for the digestion of egg-white (protein)?

Ans: These are: the presence of active pepsin, suitable temperature (37°C to 39°C) and proper pH (1-3) maintained by acid.

Q.9 What is the suitable temperature for the peptic-digestion of protein?

Ans: Suitable temperature for digestion of protein is same as that of human stomach, i.e., 37°C or 98.6°F

Q.10 How do the concentrations of the enzyme and the substrate affect the rate of digestion?

Ans: Within certain limits, the increasing concentrations of the enzyme and the substrate increase the rate of digestion.

Q.11 Define Enzyme and substrate?

Ans: The enzyme is a protein molecule specialized to catalyse a biological reaction (biocatalysts)

The substance upon which an enzyme acts is called substrate.

Q.12 What does an optimum condition mean?

Ans: The condition under which a chemical process occurs at the maximum rate is called optimum condition

Q.13 What is a catalyst?

Ans: Catalyst is a compound that increases the rate of a chemical reaction, without itself being used up in the process

Q.14 What are the shapes of the proteins constituting enzymes?

Ans: These are 3 dimensional, globular in shape.

Q.15 How do the enzymes accelerate the chemical reactions?

Ans: The enzymes accelerate the chemical reactions by lowering activation energy of substrate.

Q.16 How does a small change in the optimum pH value of the substrate affect enzyme activity?

Ans: A small change in the optimum pH value of the substrate (increase or decrease) lowers down the enzyme activity.

Q.17 How does an extreme change in optimum pH value of the substrate affect enzyme activity?

Ans: An extreme change in pH breaks down the bonds in the enzyme resulting in denaturation (loss of biological activity).

Q.18 How does the temperature affect the enzyme activity?

Ans: The activity of the enzyme is maximum at optimum temperature. It is minimum (lowest) at very low temperature i.e., at 0°C Reaction rate is doubled with 10°C rise in temperature up to 40°C after which it is decreased till it stops beyond 60°C due to denaturation of enzyme.

Q.19 How does increasing concentration of enzyme affect its activity?

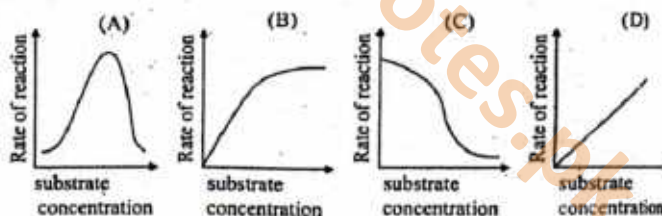
Ans: The increasing concentration of enzyme increases its activity, if enough substrate is available

Q.20 Which graph shows the expected relationship between enzyme activity and substrate concentration?

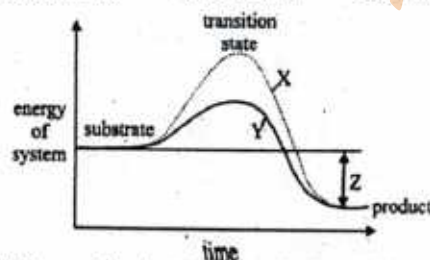
Ans: B

Q.21 The following graph shows the effect of an enzyme on a reaction.

X Y Z



(A)	catalyzed reaction	uncatalyzed reaction	activation energy
(B)	catalyzed reaction	uncatalyzed reaction	energy lost during reaction
(C)	uncatalyzed reaction	catalyzed reaction	energy gained by product
(D)	uncatalyzed reaction	catalyzed reaction	overall energy change

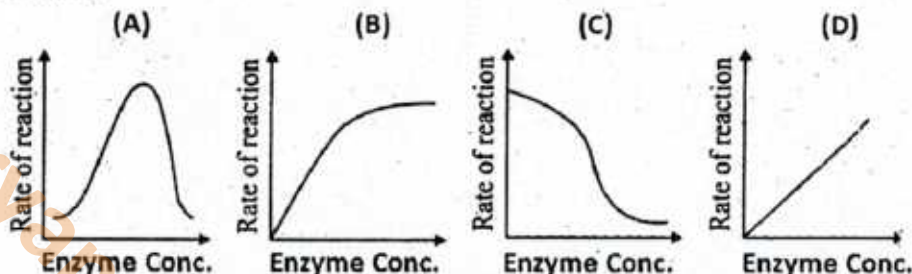


Which combination identifies X, Y and Z?

Ans: C

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Given in the following graphs is shown enzyme activity performed in laboratory at optimum temperature and pH. Observe carefully the following graphs A, B, C and D given below and Answer the following Questions:



- (i) If the substrate concentration is limited then which one of the above graphs, you suggest, is applicable and why? (1)

Ans:

- (ii) If the substrate concentration is unlimited then which one of the above graphs, you suggest, is applicable and why? (1)

Ans:

- (iii) Do you suggest any other factor responsible for drop in enzyme activity shown in graph A. Explain. (3)

Ans:

- (iv) Which kind of variables are pH and Temperature in the above graphs (1)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) **Graph-B:** The Reaction rate will not increase with more enzymes; instead, the enzyme activity will be limited by the low amount of substrate available.
- (ii) **Graph-D:** If both substrate and enzyme concentrations are unlimited, the enzyme activity will be unlimited.
- (iii) **Graph-A:** Enzyme inhibitors decrease or stop enzyme activity by binding to an enzyme and reducing the rate of a chemical reaction. The effect can be a significant slowdown or a complete halt to the reaction. Inhibitors can bind to the enzyme's active site or elsewhere, and their effect can be reversible (temporary) or irreversible (permanent). Similarly Radiations damage enzyme and substrate structure resulting into decrease or stop enzyme activity.
- (iv) Controlled variables

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-2

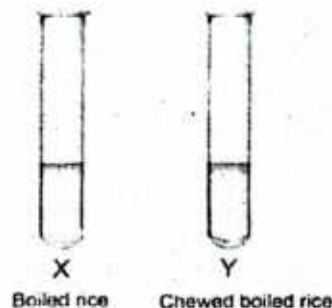
Both temperature and pH significantly affect enzyme activity, with each enzyme having an optimum temperature and pH at which it functions most efficiently.

Here in an experiment, We have two test tubes here, X and Y.

X contains boiled rice and Y contains boiled rice that has been completely chewed on.

i): Which enzyme is present in saliva? (1)

Ans: _____



ii): What would you infer from the results after 2 Hours in test tubes X and Y? (3)

Ans: _____

iii): Which one is more likely to turn blue-black on adding an iodine solution? (1)

Ans: _____

iv): What would be the optimum temperature for the digestion in test tube Y? (1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 2

i): Salivary amylase (Ptyalin).

ii): **Test tubes X:** Boiled Rice contains starch. When we add an iodine solution to the test tube X containing starch, iodine forms a starch-iodide complex. Due to this, the solution turns blue-black.
Test tubes Y: Chewed boiled rice contains saliva and starch. Saliva contains salivary amylase enzyme that breaks down starch into simple sugar. So no blue-black colour appears on applying iodine solution.

iii): X test tube.

iv): 37°C

EXPERIMENT

2

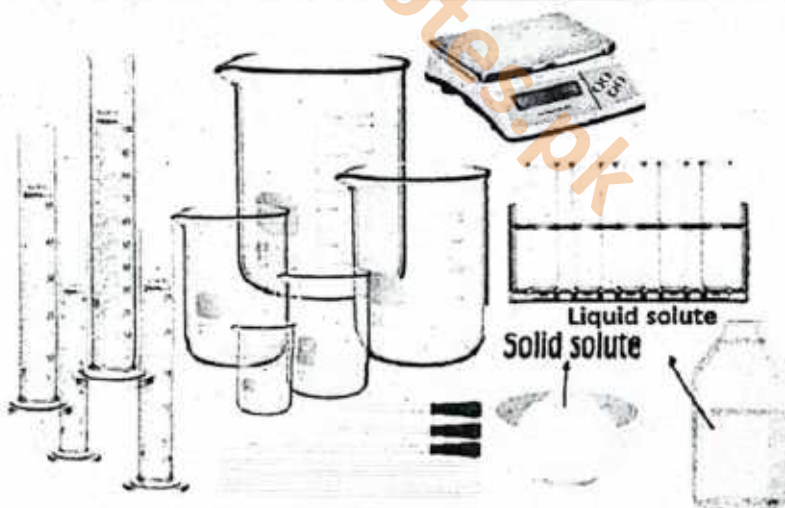
PREPARATION OF WEIGHT/VOLUME SOLUTIONS (% OR MOLAR SOLUTIONS) AND MAKING SIMPLE AND SERIAL DILUTIONS FROM STOCK SOLUTION.

THEORY AND CONCEPT:

	MOLARITY	MOLALITY
Definition	Molarity is a measure of concentration, defined as the number of moles of solute per liter of solution. It is calculated by dividing the moles of solute by the volume of the solution in liters, and its unit is moles per liter (mol/L), which is often abbreviated as M .	Molality is a measure of solution concentration that is defined as the number of moles of solute per kilogram of solvent. It is symbolized by a lowercase ' m ' and its units are moles per kilogram (mol/kg).
Formula	$M = \text{moles of solute} / \text{liters of solution}$	$m = \text{moles of solute} / \text{kilograms of solvent}$
Key Distinction	Molarity uses the volume of the total solution (solute + solvent) in liters. Molality is independent of temperature and pressure because it is based on mass, not volume.	Molality uses the mass of the solvent (e.g., kg of water) in the denominator. While molarity is dependent.
Example	A solution with a molarity of $1M$ contains one mole of solute dissolved in a total solution volume of one liter. If you dissolve 58.44 grams of table salt (NaCl) in enough water to make a total of one liter of solution, you have a $1M$ solution of NaCl .	A solution with a molality of $5m$ has 5 moles of solute dissolved in 1 kilogram of solvent.

APPARATUS AND CHEMICALS:

- Solutes (Glucose or Sucrose or NaCl or HCl or antibiotic etc.)
- Distilled water
- Pipettes
- Test Tubes
- Electrical weighing balance,
- Conical flask,
- Electric stirrer,
- Beakers/Cylinders of 100 ml, 500 ml, 1000 ml etc.



(A) STOCK SOLUTION AND ITS PREPARATION

A **stock solution** is a concentrated solution that is prepared to be diluted to a lower concentration for various laboratory uses. It's a way to create a working solution, saving time, conserving materials, and improving accuracy when preparing solutions.

OR

Stock solutions can best be described as concentrated solutions of known, accurate concentrations that will be diluted for future laboratory use. For example, a 1% stock solution is prepared by dissolving 1 g of solute in 100 g of water.

PROCEDURE/PREPARATION OF STOCK SOLUTION: To prepare a **1M (1 molar) stock solution**, we need to dissolve one mole of a substance (molar mass of the solute) in a solvent to make a final volume of 1 liter. The required stock solution can be prepared by following steps:

1. Calculate the required mass:

Determine the molar mass of the given solute using the atomic or molecular masses.

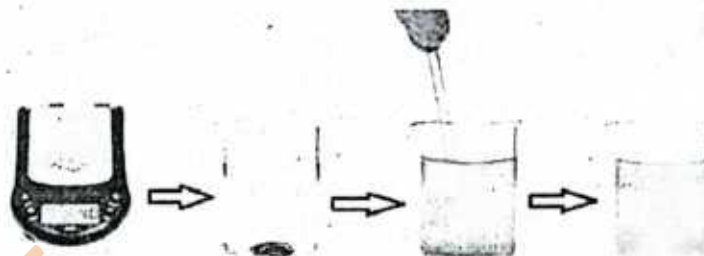
For example: molar mass of **glucose** $C_6H_{12}O_6$ molecule is: $(12 \times 6 + 1 \times 12 + 16 \times 6 = 180 \text{ g})$

2. Prepare the solution:

Use a volumetric flask (or another appropriate graduated cylinder/Beaker) and add in it the calculated mass of your solute e.g., For 1M Glucose, 180 g of glucose powder. Now add water (distilled) in beaker up to the volume reaches 1 litre (1000 ml).

3. Mix thoroughly:

If the solute is a solid, make sure it dissolves completely by gently swirling or stirring the solution or heat if necessary.



1. Weighing the solute

2. Add solute to beaker

3. Add water and mix well

(B) MAKING SIMPLE DILUTIONS FROM STOCK SOLUTION

For making different dilutions of desired/ required concentrations and volumes from the stock solution following equation/ formula can be used:

$$C_1V_1 = C_2V_2$$

- C_1 : Represents the concentration of the stock solution (e.g., molarity, percent solution).
- V_1 : Represents the volume of the stock solution you need to use.
- C_2 : Represents the desired concentration of the diluted solution.
- V_2 : Represents the desired total volume of the diluted solution.

STEPS:

1. Add solvent to a flask:

Add a small amount of solvent (e.g., distilled water) to a flask or graduated cylinder that is large enough to hold the final volume.

2. Add the stock solution:

Carefully measure the calculated (from the above-mentioned formula) volume of the stock solution (V_1) and add it to the flask containing the solvent.

3. Dilute to the final volume:

Add more solvent to the flask until you reach the desired final volume (V_2).

4. Mix thoroughly:

Ensure the solution is well-mixed by swirling or inverting the flask.

(C) MAKING SERIAL DILUTIONS FROM STOCK SOLUTION

As we have prepared 1M stock solution above; Serial dilutions can be made from the stock solution by the following way;

- 1. Preparation of 0.1M solution:** Take 1 ml from the 1 M stock solution with the help of a pipette in the measuring cylinder as shown in the following Figure. Add 9 ml distilled water to make it total 10 ml solution, this solution will be **0.1 M**.
- 2. Preparation of 0.01M solution:** Take 1 ml from the second solution with molarity 0.1 M in another cylinder and add 9 ml distilled water, now this solution will be of **0.01 M**.
- 3.** Further dilutions can be made in this way as shown in the following Figures.
- 4.** In this serial, **dilution factor will be 10**, as each next solution is becoming 1/10 M of the previous one.

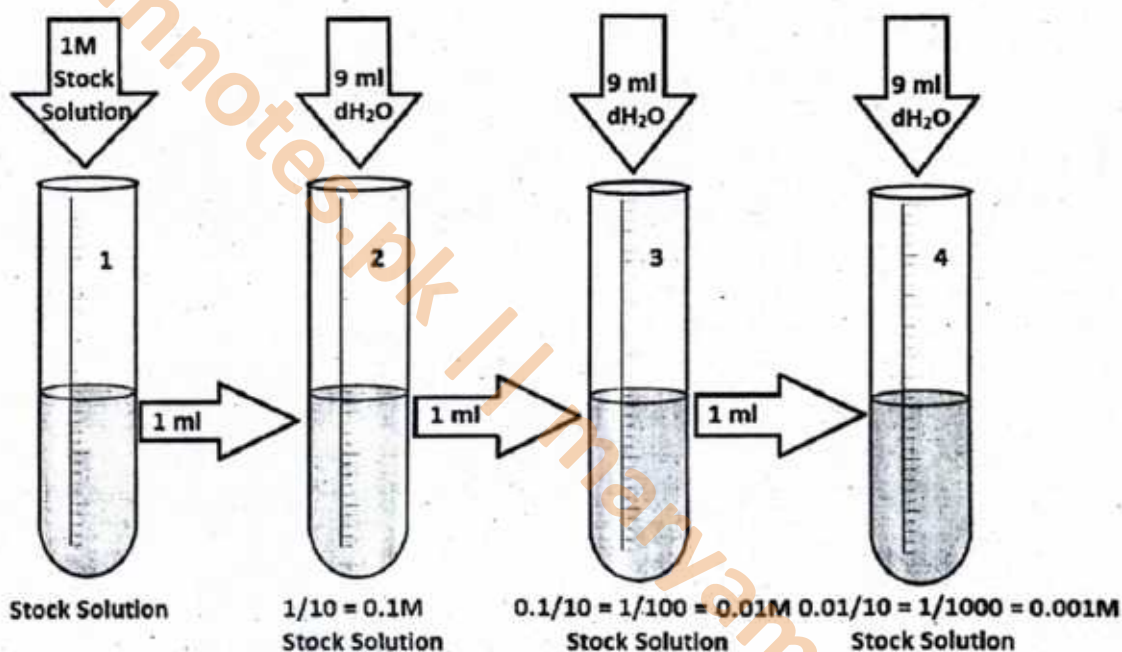


Figure: Serial dilutions from a Stock Solution

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q. 1: What is the difference between stock solution and standard solution?

Ans: A stock solution is a concentrated solution that serves as a source of a diluted solution, whereas a standard solution is a solution with a precisely known concentration. The distinction is crucial for precision in analytical chemistry.

Q. 2: What does 1% stock solution mean?

Ans: A stock solution is defined as a solution containing a predetermined amount of dyestuff dissolved in a specified quantity of water, allowing for accuracy and convenience in achieving different dye shades. For example, a 1% stock solution is prepared by dissolving 1 g of dye in 100 g of water.

Q. 3: What is a 0.1% stock solution?

Ans: The 0.1% solution is 1/10 th the strength of the 1.0% solution. If you want to make 100 ml of the 0.1% solution using the 1.0% solution, put 10 ml of the 1.0% solution in a 100 ml graduated cylinder and add distilled water to fill the 100 ml graduated cylinder to the 100 ml mark.

Q. 4: How to make 100 mg/ml stock solution for ampicillin?

Ans: Weigh 100 mg (0.1 g) of Ampicillin.

1. Add the Ampicillin to a 1.5 mL tube.
2. Add deionized water to the 1 mL level on the tube.
3. Store the tube in the -20°C freezer

Q. 5: Why do we use stock solutions?

Ans: Stock solutions can save a lot of time, conserve materials, reduce needed storage space, and improve the accuracy with which we prepare solutions and reagents.

Q. 6: What does a 0.5% solution mean?

Ans: 0.5% means 0.5 grams in 100 ml.

Q. 7: How to calculate how much stock solution is needed?

Ans: The calculator uses the formula $M_1V_1 = M_2V_2$ where "1" represents the concentrated conditions (i.e., stock solution molarity and volume) and "2" represents the diluted conditions (i.e., desired volume and molarity). To prepare a solution of specific molarity based on mass, please use the Mass Molarity Calculator.

Q. 8: What is molality?

Ans: Molality is a measure of solution concentration that is defined as the number of moles of solute per kilogram of solvent. It is symbolized by a lowercase 'm' and its units are moles per kilogram (mol/kg).

Q. 9: How molality is different from molarity?

Ans: Unlike molarity, molality is independent of temperature and pressure because it is based on mass, not volume.

Q. 10: Write the formula of molality.

Ans: Formula: Molality (m) = moles of solute / kilograms of solvent

Q. 11: What is molarity?

Ans: Molarity is a measure of concentration, defined as the number of moles of solute per liter of solution. It is calculated by dividing the moles of solute by the volume of the solution in liters, and its unit is moles per liter (mol/L), which is often abbreviated as M .

Q. 12: Write the formula of molarity.

Ans: Molarity formula:

Molarity = moles of solute / liters of solution

Q. 13: What is 2% of a solution?

Ans: Solvent is in a generally liquid or gaseous state in which the solute dissolves to form a solution. To make a proper 2 percent solution, they should specify a solvent but the general way to make a 2 percent solution is to get 2 grams of solvent and dissolve it in 98-100 ml of water.

Q. 14: Another solution commonly used for intravenous injections is normal saline, a 0.16 M solution of sodium chloride in water. Calculate the mass of sodium chloride needed to prepare 250 mL of normal saline solution.

Ans: 2.3 g NaCl

Q. 15: What volume of a 3.00 M glucose stock solution is necessary to prepare 2500 mL of the D5W solution in Example 4?

Ans: 0.258 L or 258 mL.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

The so-called D5W solution used for the intravenous replacement of body fluids (when body glucose level is low). (D5W is an approximately 5% solution of dextrose [the medical name for glucose] in water.):

- (i) D5W solution is 5% solution of dextrose [the medical name for glucose] in water. Calculate the molarity of the solution: (2)

Ans:

- (ii) Calculate the mass of glucose necessary to prepare a 500 mL pouch of D5W. (2)

Ans:

- (iii) What does a 0.5% solution mean? (1)

Ans:

- (iv) What volume of a 5.0 M NaCl stock solution is necessary to prepare 500 mL of normal saline solution (0.16 M NaCl)? (1)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) D5W is a 5% dextrose (glucose) in water solution, which typically means 5% weight/volume (w/v) in medical contexts. This means there are 5 grams of glucose in every 100 mL of solution.
- To find the amount in one liter (1000 mL), we can scale up:

$$\text{Mass in 1 L} = 5 \text{ g} / 100 \text{ mL} \times 1000 \text{ mL} = 50 \text{ g}$$
 - Using the mass and molar mass, the number of moles (n) in 50 g is calculated as:

$$n = \text{mass} / \text{molar mass} = 50 \text{ g} / 180.16 \text{ g/mol} = 0.2775 \text{ moles}$$
 - Molarity (M) is defined as moles of solute per liter of solution:

$$\text{Molarity} = \text{moles of solute} / \text{volume of solution (L)} = 0.2775 \text{ mol} / 1\text{L} = 0.2775 \text{ M}$$
- (ii) We must first calculate the number of moles of glucose contained in 500 mL:

$$\text{Molarity of glucose} / 1\text{L (1000 ml)} = 0.2775 \text{ M then}$$

$$\text{Molarity of glucose} / 500 \text{ ml} = 0.13875 \text{ M}$$
 We then convert the number of moles of glucose to the required mass of glucose:

$$\text{Mass of glucose} = \text{moles of glucose} \times \text{molar mass of glucose} / \text{L}$$

$$= 0.13875 \times 180.16 / 1\text{L} = 25 \text{ g glucose}$$
- (iii) 0.5% means 0.5 grams in 100 ml, so if you only need 50 ml, you need $0.5 \text{ g} / 2 = 0.25 \text{ g}$ for a 50 ml solution. Mathematically: $0.5 \text{ g}/100 \text{ ml} = X \text{ g}/50 \text{ ml}$.
- (iv) 16 mL.

EXPERIMENT

3

TO INVESTIGATE THE CONCENTRATION OF REDUCING SUGAR (GLUCOSE) BY BENEDICT'S TEST USING THE COLORIMETER.

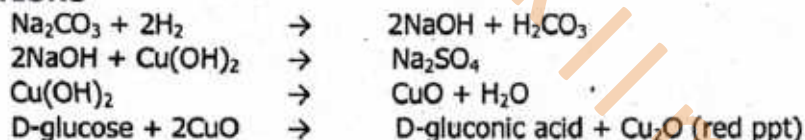
DEFINITION

Benedict's test is a biochemical test performed to distinguish reducing sugars (monosaccharides and some disaccharides) from non-reducing sugars.

PRINCIPLE

- Benedict's solution-blue solution containing copper (II) sulphate. Reducing sugars such as glucose, maltose, fructose and lactose can reduce the copper (II) in Benedict's solution to copper (I).
- Benedict's solution is used to detect the presence of reducing sugars (like glucose etc.) in a solution.

REACTIONS

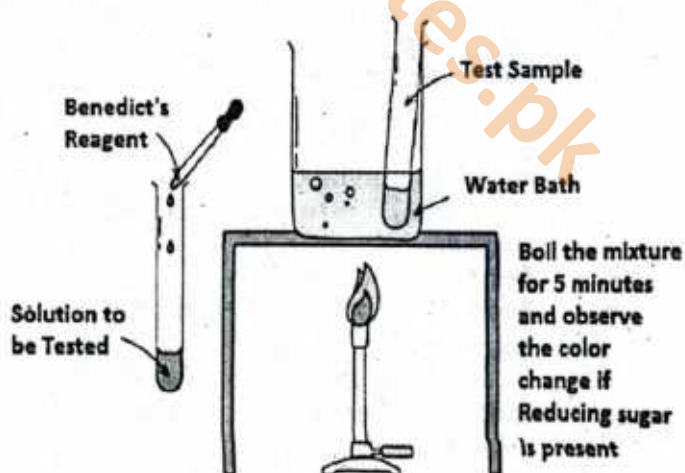


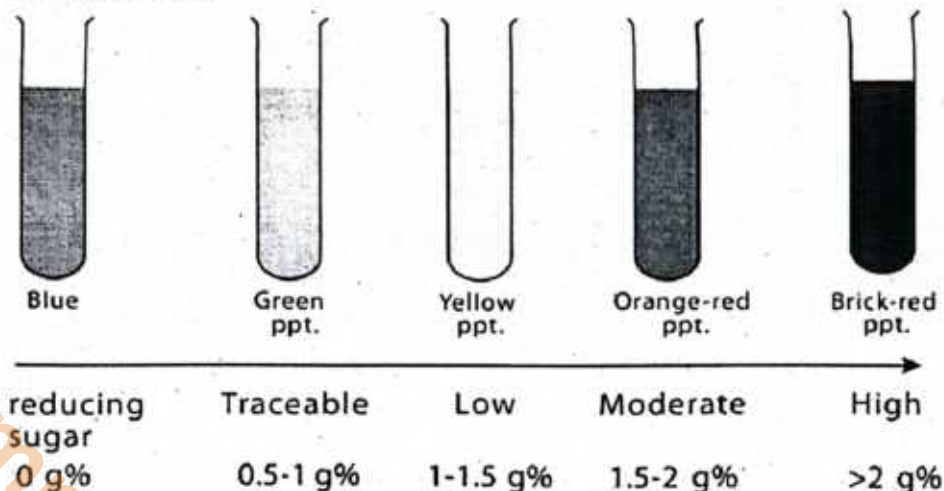
APPARATUS AND CHEMICALS

- Test tubes
- Pipettes
- **Test samples** (Glucose solution, Maltose solution, Lactose solution etc).
- **Benedict's reagent:** Measure 17.3 grams of copper sulfate (CuSO_4), 173 grams of sodium citrate ($\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$), and 100 grams of anhydrous sodium carbonate (Na_2CO_3) (or 270 grams of sodium carbonate decahydrate ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$)). Put all the measured chemicals in a volumetric flask of 1000 ml. Pour distilled water up to 1000 ml marking. Dissolve all the components properly by shaking gently.
- Test tube stand
- Water bath
- colorimeter
- Beakers

PROCEDURE USING BENEDICT'S REAGENT:

- About 1 ml of the test sample is added to a test tube along with 2 ml of benedict's reagent.
- The test tubes are then placed in the test tube stand, which is kept in boiling water for 4-10 minutes.
- The color in the test tubes are observed and noted down.

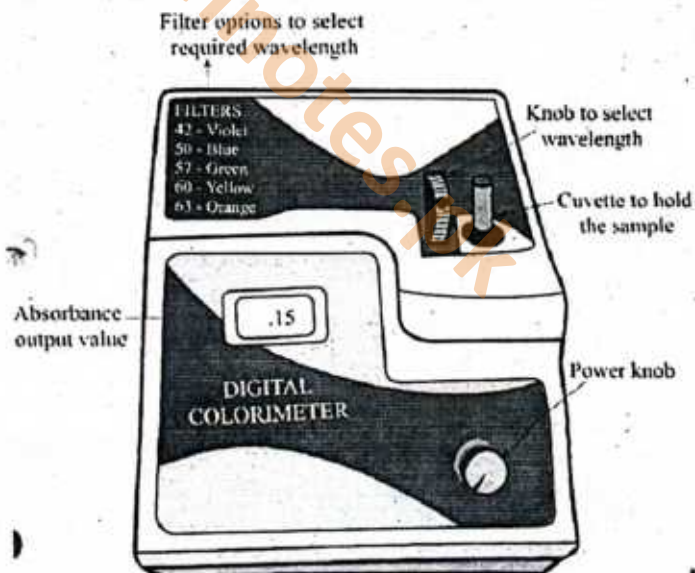


RESULT AND INTERPRETATION:**Figure: Observation (Results) of Benedict's Test.****CONFIRMATORY TESTS FOR GLUCOSE (Monosaccharide/Reducing sugars):**

EXPERIMENT	OBSERVATION	INFERENCE
1. Benedict's Test: 2 ml of O.S(original Solution) + 2 ml of Benedict's solution + Heat/Boil For 2-5 minutes.	If Initial blue color remains: If Initial blue color changes to Green Ppt: If green color changes to yellow precipitate: If yellow color changes to orange-red: If orange-red color changes to Brick-red precipitate.	Glucose/Reducing sugar is absent. Glucose/Reducing sugar is present in traces ($\pm 15\%$). Glucose/Reducing sugar is present in Low amounts ($\pm 35\%$). Glucose/Reducing sugar is present in Moderate amounts ($\pm 55\%$). Glucose/Reducing sugar is present in High amounts ($\pm 75\%$).
2. Fehling's Test: 2 ml of O.S. + 2 ml of Fehling's A and B + boil.	Initial color changes to green to yellow and finally to an orange/red PPT.	Glucose is confirmed.

USE OF COLORIMETER**PROCEDURE:****A. Measuring the known solution (Setting colorimeter calibration and plotting calibration curve):**

- Preparation of Standard Solutions:**
 - Prepare a series of glucose solutions with known concentrations (e.g., 0, 2, 4, 6, 8, 10 mmol/dm³). These will be your standard solutions.
- Benedict's Reagent:**
 - Add a fixed volume of Benedict's reagent to each standard solution.
 - Incubate the solutions in a water bath at a specific temperature (e.g., 70°C for 5 minutes) to allow the reaction to occur.



3. Filtration :

- If using Benedict's reagent, a precipitate may form.
- Filter each solution (if needed) using a suitable filter paper or a centrifuge.
- Filtering the solution will remove this precipitate, ensuring accurate colorimeter readings.

4. Colorimeter Calibration:

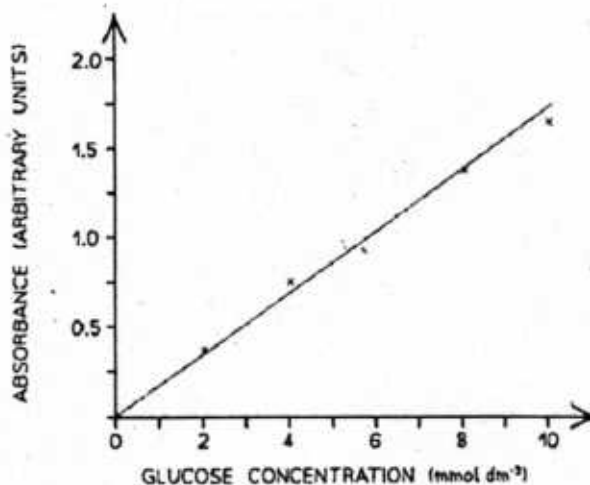
- Use distilled water or a blank solution (without glucose) as a reference. Calibrate the colorimeter using the blank solution, setting it to 0 absorbance or 100% transmission.

5. Measuring Absorbance:

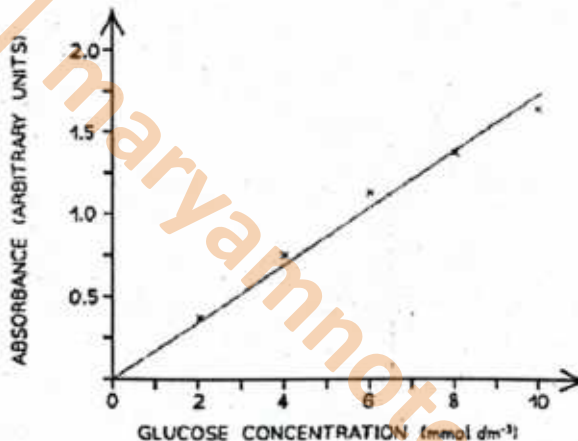
- Place each standard solution (known conc. of glucose solutions in a cuvette) into the colorimeter and record the absorbance or % transmission.
- Now Repeat the measurements for each standard solution to ensure accuracy.

6. Creating the Calibration Curve:

- Plot the absorbance values (or % transmission) against the known concentrations of the standard solutions.
- This plot is your **calibration curve**, which shows the relationship between absorbance and glucose concentration as shown in the above graph.

**B. Measuring the solution with unknown glucose concentration:**

- Treat your unknown glucose solution in the same way as the standards (react with Benedict's reagent, heat, and filter).
- Place the unknown solution in the colorimeter and measure its absorbance.
- Using the calibration curve, find the concentration that corresponds to the absorbance value of your known solution.
- For instance if the colorimeter reading is 1.25 then we can calculate glucose conc. by using calibration curve as shown in the graph i.e, 6.5 mmol/dm³

**OBSERVATIONS:**

By developing the calibration curve for known sample solutions, we can further evaluate/record the values of unknown samples in the form of a table, and then in the form of a bar graph, line graph etc.

Sr. No.	Glucose conc. (mmol/dm ³)	Absorption value by colorimeter
1		
2		
3		
4		
5		

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

A colorimeter is an instrument that beams a specific wavelength (colour) of light through a sample and measures how much of this light is absorbed by the sample. Given table shows arbitrary values for absorbance through glucose solutions with known concentrations:

glucose conc (mmol dm ⁻³)	absorbance (arbitrary units)
0.0	0.00
2.0	0.06
4.0	0.14
6.0	0.23
8.0	0.36
10.0	0.50

(i) Plot a graph for the given table: (2)

Ans:

(ii) What type of relation is shown by the graph between absorbance and glucose concentration? (1)

Ans:

(iii) What colour of the glucose solution with Benedict reagent treatment do you expect at absorbance rate of 0.0 and 0.50? (2)

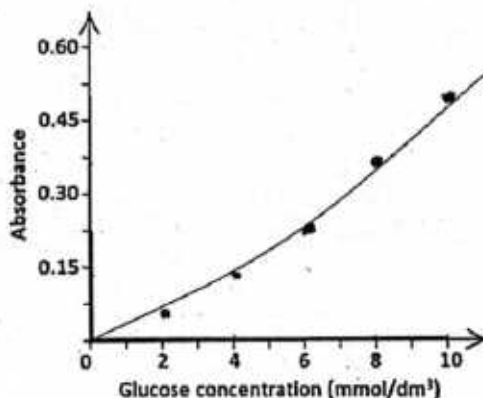
Ans:

(iv) What is meant by calibration curve? (1)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)



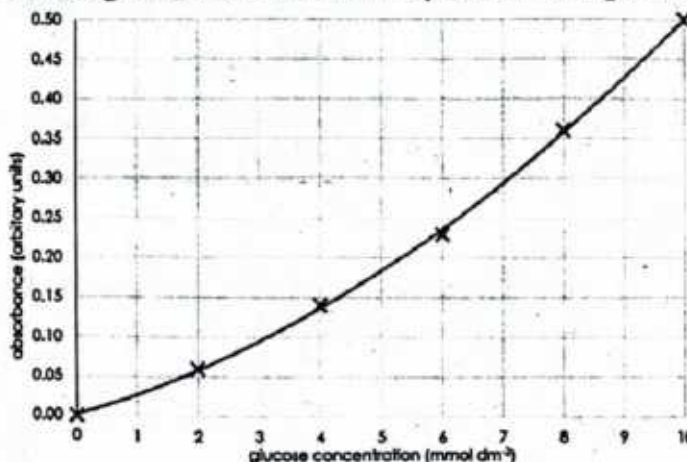
(ii) Relation shown in the graph between absorbance and glucose concentration is directly proportional i.e., as the absorbance rate reading of colorimeter increases, glucose concentration also increases and vice versa.

(iii) 0.00 = blue color (no glucose) 0.50 = Orange-red color colour (high glucose level)

(iv) **calibration curve** shows the relationship between absorbance and glucose concentration in the form of graph.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

The colorimeter compares the intensity of the light before and after it passes through the solution. A higher concentration of a colored solute will absorb more light, resulting in a lower transmittance reading. Given in the graph are values of absorbance at known glucose concentrations. Three samples T, D and H of unknown glucose concentrations show the absorbance units at colorimeter:



- (i) Calculate the values of T and D following the graph: (2)

Ans: _____

- (ii) Which sample has more and less concentration of glucose. (2)

Ans: _____

Unknown sample	absorbance (arbitrary units)	glucose conc (mmol dm ⁻³)
T	0.11	
D	0.36	
H	0.04	

- (iii) In samples H and D, What colour do you expect if treated with Benedict reagent? (1)

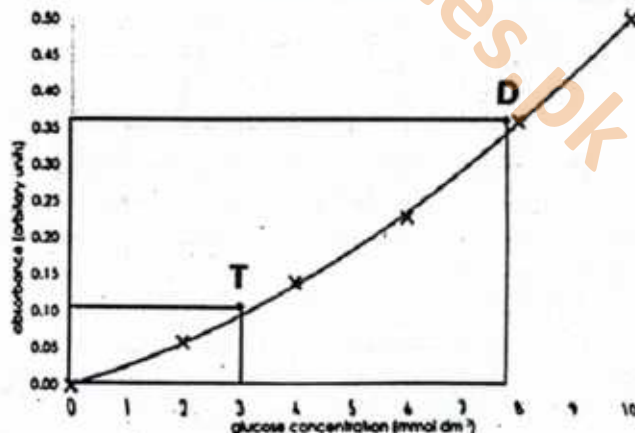
Ans: _____

- (iv) If the absorbance value is 0.24 then what would be glucose concentration according to above graph? (1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- (i) T = 2.9 mmol/dm³
D = 7.9 mmol/dm³
- (ii) H = blue color (no/very low glucose)
T = Orange-red color colour (moderate to high glucose level)
D = Dark-red colour (high glucose level)
- (iii) H = blue color (no/very low glucose)
D = Dark-Red colour (high glucose level)
- (iv) 6 mmol/dm³



EXPERIMENT

4

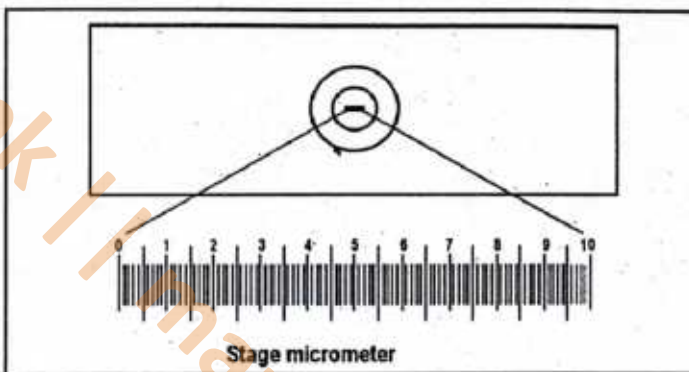
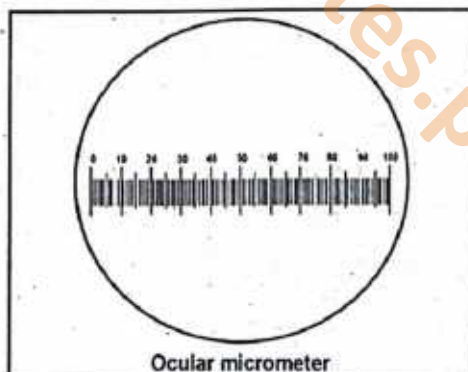
TO MEASURE THE SIZE OF A TISSUE OR CELL USING EYE PIECE GRATICULE OR OCULAR MICROMETER AND STAGE MICROMETER.

Measurement of cells by Micrometry

Two types of micrometers are used in micrometry: Ocular micrometer and stage micrometer.

1. Ocular micrometer:

It is a transparent rounded glass piece. A scale is present on it. This scaled is divided into 100 divisions. But the measurement of each division is unknown. Ocular micrometer is placed between two lenses of ocular or eye piece.



2. Stage micrometer:

It is slide like micrometer. It is fixed on the stage with the help of clips. It has a scale on it. This scale is divided into 100 divisions. The measurement of this scale is known as follows:

Total length of the scale (100 divisions) of stage = 1 mm = 1000 micron

Length of one division of ocular is = $1/100 = 0.01 \text{ mm} = 10$

Therefore, one division of stage micrometer = 10 micron (1 = 10^{-6})

Apparatus:

- Stage micrometer
- Microscope
- Ocular micrometer
- Prepared slides

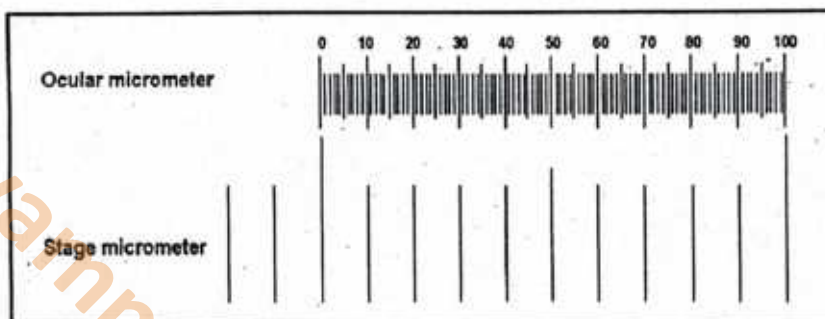
Procedure:

- The eye piece is removed. Its lid is opened and ocular micrometer is placed in it.
- The stage micrometer is fixed on stage of microscope with the help of clips.
- The ocular is turned round till ocular micrometer and stage micrometers are brought parallel to each other.
- A line is traced out where a line of ocular and a line of stage exactly match with each other.
- Another line of ocular is traced away from first matched line. This line tally with the line of stage micrometer.
- Divisions of ocular & stage micrometer are counted between first matched line & second matched line.

Calculations:

10 divisions of ocular micrometer (Graticule)
 1 division of ocular micrometer
 We know that 1 division of stage
 1.5 division of stage micrometer
 Therefore, 1 division of ocular

= 15 divisions of stage micrometer
 = $15/10$ = 1.5 divisions of stage
 = 10 μ m = 0.01 mm
 = 10×1.5 = 15 μ m
 = 15 μ m

**Measurement of cell**

- Now stage micrometer is removed.
- The given slide for measurement of specimen is taken. This slide is placed on microscope.
- First numbers of divisions of ocular for length of the specimen are counted.
- Then ocular is rotated and numbers of divisions for width are counted.
- Suppose the length of the object is 8 divisions of ocular micrometer, the length of the object will be as given in result.

Result

The length of the given cell = $8 \times 15 = 120 \mu\text{m}$.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. Name two lenses of microscope?

Ans: Ocular and objective

2. What is difference between compound and electron microscopes?

Ans: The source of illumination for compound microscope is simple light. But the source of illumination for electron microscope is moving electron.

3. Why is compound microscope called so?

Ans: Multiple lenses are used in compound microscope. Therefore it is called compound microscope.

4. What is meant by magnification of microscope?

Ans: The number of times which a microscope increases the size of an object as compared to its original size is called magnification of microscope.

5. What is the power of resolution?

Ans: Minimum distance between 2 points in which our eye can differentiate is called resolution of eye.

6. What is a microscope?

Ans: A microscope is an instrument, used to magnify small objects that cannot be seen by the naked eyes.

7. What is an electron microscope?

Ans: An electron microscope is a device used to study the ultra structure of muscles and other cell organelles. In electron microscope, a beam of high speed electrons is used for magnification.

8. How many times does an electron microscope magnify?

Ans: An electron microscope magnifies the object about 2,50,000 times than naked eye.

9. How many times does a compound microscope magnify?

Ans: Magnifying power of a compound microscope is equal to the magnifying power of the objective lens into the magnifying power of the eyepiece lens.

Accordingly the magnifying power can vary from 100 times (10x 10) to 600. Times (15x 40).

10. Name various other types of microscopes?

Ans: Phase contrast microscope, Fluorescent microscope, JV microscope, Polarizing microscope, Interference microscope etc.

11. Who observed the cells for the first time under the first microscope?

Ans: Robert Hooke in 1665 in a thin slice of cork.

12. Who invented electron microscope?

Ans: Electron microscope was invented by Knoll and Rusaka in 1932.

13. When do you use the concave surface and the plain surface of a mirror in the microscope?

Ans: The plain surface of a mirror is used to focus the light rays for a brightly illuminated object like sun rays while concave surface is used to focus the diffused light rays like the ones coming from a lamp or a tube light.

14. What are photomicrographs?

Ans: Photographs taken through the microscope are called photomicrographs.

15. What type of microscope can be used for observing mitosis in living cells?

Ans: Phase contrast microscope.

16. What is phase contrast microscope?

Ans: It is used for observing transparent objects and it can increase the contrast between various parts of the object.

17. What is Binocular?

Ans: A kind of compound microscope with two oculars but with single objective functional at a time. So the image is not stereoscopic.

18. What types of mirrors are used in a compound microscope?

Ans: Plane, concave.

19. State function of:

i. Ocular	ii. Revolving nose piece	iii. Body tube	iv. Diaphragm
v. Object	vi. Stage	vii. Mirror	viii. The arm
ix. Base	x. Coarse and fine adjustment screws		

Ans: See diagram of microscope.

20. Convert 3 mm to micron/ μm ?

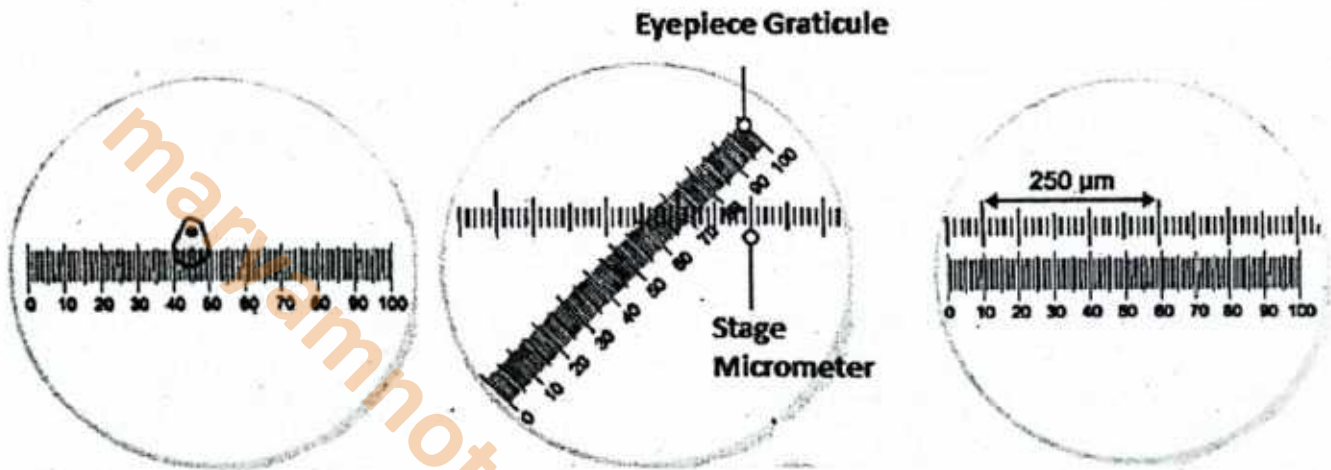
Ans: 1 meter = 1000000 μm = 1000 mm
 or 1000 mm = 1000000 μm
 or 1 mm = 1000000/1000 = 1000 μm
 or 3 mm = 1000 x 3 = 3000 μm

21. Calculate how many nanometers are in 5 millimeters?

Ans: 1 meter = 1000000000 nm
 1 meter = 1000 mm = 1000000000 nm
 1 mm = 1000000000/1000 = 1000000 nm
 5 mm = 5 x 1000000 nm or = 5 x 10⁶ nm

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Given below is the diagram of micrometry apparatus set up and a unicellular slide on eyepiece graticule.



- (i) What would be the length of a cell, to two significant figures, that was 35 divisions on this graticule? (3)

Ans:

- (ii) What would be the width of a cell, to two significant figures, that was 35 divisions on this graticule? (1)

Ans:

- (iii) How many graticule divisions would a single celled organism that was $240\text{ }\mu\text{m}$ take up? (1)

Ans:

- (iv) A muscle cell is 1 meter long; convert it into microns. (1)

Ans:

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

- (i) When viewed under a light microscope, the size of the cell in the diagram was 20 mm. The magnification of the image was X 400. What is the actual size of the cell and give your answer in μm (micrometres)? (3)

Ans: _____

- (ii) Size of an amoeba is one third of a millimeter; calculate its size in micrometer? (1)

Ans: _____

- (iii) When do you use concave surface and the plain surface of a mirror in the microscope? (1)

Ans: _____

- (iv) When a phase contrast microscope is used? (1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) One division is equal to $4.9 \mu\text{m}$.
Width of cell highlighted = $52 - 40 = 12$ eyepiece graticule divisions.
The real width of the cell is $12 \times 4.9 \mu\text{m} = 59 \mu\text{m}$ (to two significant figures).
The real width of the cell is $35 \times 4.9 \mu\text{m} = 171.5 \mu\text{m}$ (To two significant figures, this is **170 μm Ans.**)

Explanation

The distance of $250 \mu\text{m}$ on the stage micrometer lines up against two divisions at 10 and 61 on the eyepiece graticule.
 $61 - 10 = 51$ divisions on the eyepiece graticule are equivalent to $250 \mu\text{m}$ on the stage micrometer.
One division on the eyepiece graticule = $250 / 51 \mu\text{m}$ on the stage micrometer = $4.9 \mu\text{m}$ (to two significant figures).

- (ii) Each eyepiece graticule division is $4.9 \mu\text{m}$
The real width of the cell is $35 \times 4.9 \mu\text{m} = 171.5 \mu\text{m}$
To two significant figures, this is **170 μm Ans.**
- (iii) Each graticule division is $4.9 \mu\text{m}$
An organism that measured $240 \mu\text{m}$ would take up
 $240 / 4.9$ divisions = 49 divisions. **Ans.**
- (iv) $1000000 \mu\text{m}$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- (i) Actual length = measured size / magnification
 $20 \text{ mm} / 400 = 0.05 \text{ mm}$
Since $(1 \text{ mm} = 1000 \mu\text{m})$
The actual size = $50 \mu\text{m}$ **Ans.**
- (ii) Size of an amoeba is $1/3$ of a mm = 0.33 mm
 $1 \text{ mm} = 1000 \mu\text{m}$
 $0.33 \text{ mm} = 0.33 \times 1000 \mu\text{m} = 333.333 \mu\text{m}$ **Ans.**
- (iii) The plain surface of a mirror is used to focus the light rays for a brightly illuminated object like sun rays while concave surface is used to focus the diffused light rays like the ones coming from a lamp or a tube light.
- (iv) It is used for observing transparent objects and it can increase the contrast between various parts of the object.

EXPERIMENT

5

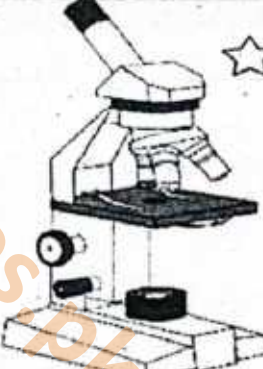
TO MEASURE THE ACTUAL SIZE, IMAGE SIZE AND MAGNIFICATION OF A TISSUE OR CELL FROM PHOTOMICROGRAPHS USING SCALE BAR OR MILLIMETRE RULER.

APPARATUS:

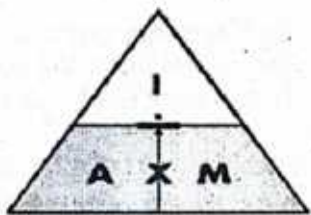
- Rulers (mm)
- Pencil
- Calculator
- Magnifying lens
- Microscope
- specimen slides
- Microphotographs

PROCEDURE:

To calculate the actual size, image size, and magnification of a tissue or cell from a photomicrograph using a scale bar or a millimeter ruler, we need to measure the image size, the scale bar length, and then apply the appropriate formulas as shown in the diagram above.



★ The 'I AM' triangle is a great way to remember the formula for calculating magnification.



Magnification = Image size ÷ Actual size

The formula can be rearranged. Complete the correct rearrangements below:

Actual size = **image / magnification**

Image size = **actual x magnification**

Converting Units	
When studying very small structures, such as inside cells, appropriate units need to be used.	
Micrometers, μm , are the units used. There are a 1000 μm in 1 mm.	
Convert the following into micrometers:	Convert the following into millimetres:
1. 3mm = 3000 μm	1. 1.5 μm = 0.0015 mm
2. 0.2mm = 200 μm	2. 0.5 μm = 0.0005 mm
3. 0.008mm = 8 μm	3. 37.5 μm = 0.037 mm

1. Magnification = image size ÷ actual size.
2. Actual size = image size ÷ magnification.
3. Image size = actual size x magnification.

(A) CALCULATING THE REAL (ACTUAL-A) SIZE OF AN OBJECT FROM ITS MAGNIFICATION

We can calculate the actual size of the object using the image size and the calculated magnification. For better understanding Lets take an example: (make sure all the measurements are in the same units).

A cheek cell is magnified 600 times, the width of the image size is 10mm. work out the real width of the cell give your answer in micrometres.

What does the question tell us?

Magnification = 600 times

Image size = 10mm

I need to find the Real size

X 1000

mm – millimetres

µm – micrometres

$$\text{Real size} = \frac{\text{Image size}}{\text{magnification}} = \frac{10}{600} = 0.016\text{ mm} \times 1000 = 16.6\mu\text{m}$$

(B) CALCULATING MAGNIFICATION (M) FOR A SCALE BAR

First, measure the image size and the scale bar (which represents a known actual size) on the photomicrograph. Then, calculate the magnification using the scale bar and its known actual size. For better understanding Lets take an example:



What do we already know?

Image length = 50mm

Scale bar image
(measured length) = 13mm

Scale bar represents 20µm
(scale bar label)

Calculate magnification first, then actual size

$$\begin{aligned} \text{magnification} &= \frac{\text{measured length}}{\text{scale bar label}} \\ &= \frac{13000\mu\text{m}}{20\mu\text{m}} \quad (13\text{mm}) \\ \text{magnification} &= 650\text{x} \end{aligned}$$

(C) CALCULATING THE MAGNIFICATION (M) OF A PHOTOMICROGRAPH OR IMAGE

Lets take an example of electron micrograph of a mitochondrion. The Actual size of mitochondrion is 8 µm. Lets determine its magnification.

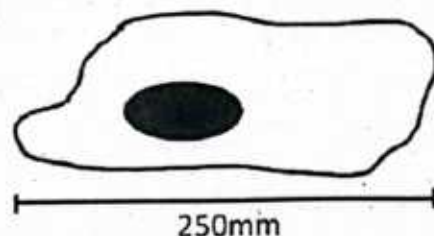


$$\text{Magnification} = \frac{\text{image size}}{\text{actual size}} = \frac{63\text{mm}}{8\mu\text{m}} = \frac{63000\mu\text{m}}{8\mu\text{m}} = 7875\text{x} \sim 8000\text{x}$$

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

A student is studying amoeba slide under microscope. He calculated the length of the amoeba 250 mm as shown in the image. The microscope he is using has ocular lens of 10X and objective lens 35X:

(2)



(i) Calculate magnification of the microscope:

Ans: _____

(ii) What is the actual length of amoeba?:

(2)

Ans: _____

(iii) Convert 3cm into mm, micrometer:

(1)

Ans: _____

(iv) Actual size of the cell is 300 μm ; calculate its magnification:

(1)

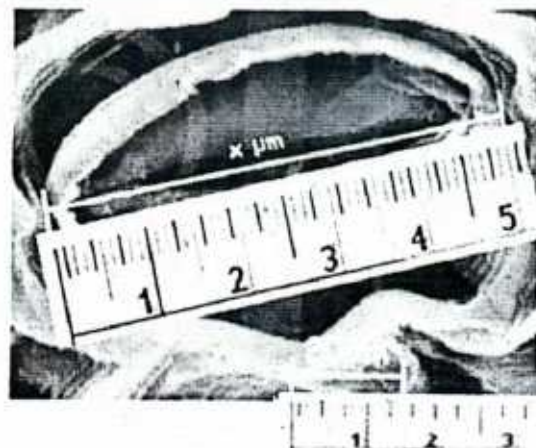
Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) Magnification Power of CM = Magnification Power of objective lens X Magnification Power of ocular lens
Magnification Power of CM = $35 \times 10 = 350 \times$
- (ii) Actual size = Measured length/Magnification
Actual size = $250/350 = 0.71 \text{ mm} = 710 \mu\text{m}$
- (iii) $3 \text{ cm} = 30 \text{ mm} = 30,000 \mu\text{m}$
- (iv) Magnification = Image size / Actual size = $250\text{mm} / 0.3 \text{ mm} = 833.3 \text{ mm}$

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

A student is studying a photomicrograph of a stoma. She measures scale bar image and scale bar label as shown in the diagram:



- (i) Calculate magnification of the image: (2)

Ans: _____

- (ii) Calculate the actual size of the image: (2)

Ans: _____

- (iii) Write the formula to calculate magnification power of a compound microscope: (1)

Ans: _____

- (iv) If the power of ocular lens is 10 X then what would be the power of objective lens?: (1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- (i) Magnification = Measured length/scale bar label
 Magnification = $13000\mu\text{m}/20\mu\text{m} = 650\text{X}$
- (ii) Actual size = Measured length/Magnification
 Actual size = $50/650 = 76.9\mu\text{m}$
- (iii) Magnification Power of CM = Magnification Power of objective lens X Magnification Power of ocular lens
- (iv) Magnification Power of ocular lens = Magnification Power of CM / Magnification Power of objective lens
 = $650 / 10 = 65\text{X}$

EXPERIMENT

6

TO INVESTIGATE HOW MUCH A BACTERIAL PATHOGEN SHOWS SENSITIVITY OR RESISTANCE TO A PARTICULAR ANTIBIOTIC BY DISC DIFFUSION METHOD (KIRBY-BAUER TEST)

THEORY

Antibiotics are medicines that are used to treat or prevent or stop some types of bacterial infections.

TYPES OF ANTIBIOTICS:

There are hundreds of different types of antibiotics, but most of them can be classified into 4 groups.

	1. PENICILLINS	2. TETRACYCLINES	3. FLOUROQUINOLONES	4. SULFONAMIDES
Usage	These are widely used to treat a variety of infections, including • skin infections, • chest infections • urinary tract infections.	These can be used to treat a <u>wide range of infections</u> .	These are <u>Broad-Spectrum Antibiotics</u> that were once used to treat a wide range of infections, especially • Respiratory tract & • Urinary tract infections. These antibiotics are no longer used routinely because of the <u>Risk of serious Side Effects</u> .	These are synthetic <u>Bacteriostatic Antibiotics</u> .
Mode of Action	They inhibit Bacterial <u>cell wall synthesis</u> by binding to penicillin-binding proteins leading to cell lysis.	They inhibit <u>protein synthesis</u> by <u>binding to 30S ribosomal</u> subunit and blocking the attachment of aminoacyl-tRNA to ribosomes.	These antibiotics inhibit <u>Bacterial DNA Replication</u> By targeting enzymes like DNA gyrase & Topoisomerase IV.	These competitively Inhibit conversion of <u>p-aminobenzoic acid</u> to <u>dihydropteroate</u> , which bacteria need for <u>Folate Synthesis</u> and Ultimately purine and DNA synthesis. <u>Humans do not Synthesize folate</u> but acquire it in their diet, so their DNA synthesis is less affected.
Examples	• Penicillin, • Amoxicillin, • Flucloxacillin etc.	• Tetracycline, • Doxycycline and • Minocycline.	• Ciprofloxacin and • Levofloxacin.	• Mafenide, • Sulfacetamide, • Sulfadiazine, • Sulfanilamide etc.

WORKING OF ANTIBIOTICS:

- Antibiotics do not work for viral infections such as cold, flu & some coughs.
- Antibiotics work by killing bacteria or stopping them from multiplying.
- Antibiotics can kill bacteria by destroying crucial parts they need to survive, like their cell walls or DNA.
- Antibiotics can stop the growth of bacteria by preventing them from making certain proteins they need to multiply.

ANTIBIOTIC RESISTENCE:

- Antibiotics are powerful germ-fighting tools when used carefully and safely. But up to half of all antibiotic use isn't necessary.
- Overuse has led to antibiotic resistance. Bacteria adapt over time and become "Super Bacteria" Or "Superbugs."
- Super bacteria cannot be killed by standard antibiotics because they have developed resistance through genetic mutations and natural selection.

Performance –I**Disc Diffusion Method (Kirby-Bauer test):**

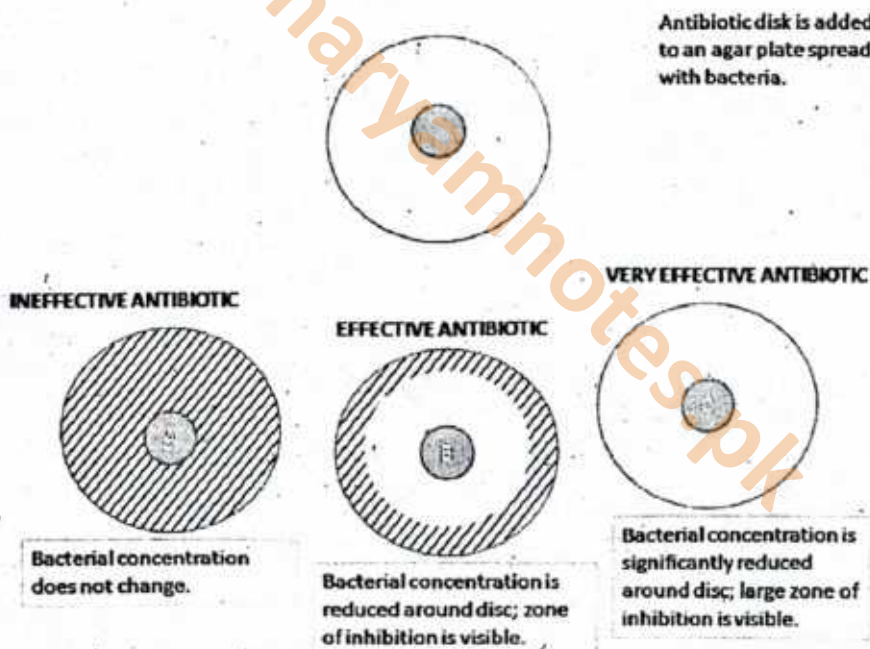
The Kirby-Bauer test, also known as the disc diffusion method, is a standardized laboratory procedure that determines a bacterium's susceptibility to antibiotics. It involves placing discs of filter papers impregnated with specific antibiotics on an agar plate in petri-dishes that has been inoculated with bacteria. As the antibiotic diffuses around the paper disc, there is formation of a bacterial free zone around the disc. Formation of a bigger zone around the disc is proportional to the effectiveness of the antibiotics against the specific bacterial strain. If there is no or little zone is formed indicates in effectiveness or resistance of bacterial culture against the antibiotic. After incubation, zones of inhibition—clear areas where bacterial growth has been stopped—are measured. The size of these zones is compared to established criteria to classify the bacteria as **sensitive**, **intermediate**, or **resistant** to the antibiotic, guiding treatment decisions.

APPARATUS AND CHEMICALS

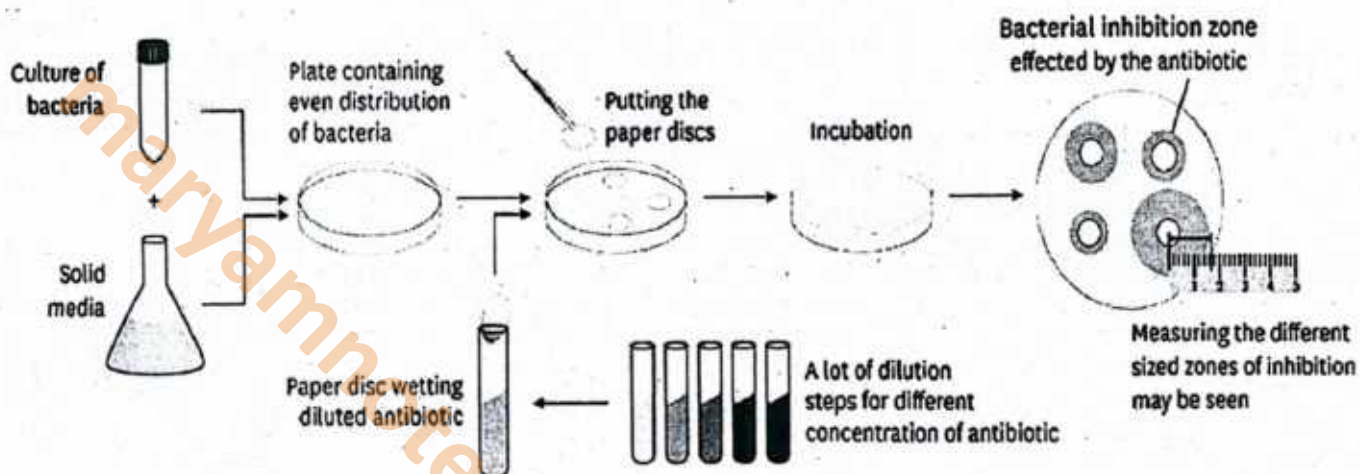
- | | | | | |
|------------------------|--|---------------|-----------------|-----------|
| • Mueller-Hinton agar, | • Autoclave, | • Test tubes, | • Petri-dishes, | • Rulers, |
| • Inoculating loops, | • paper discs, | • incubator, | • microscope, | • masks, |
| • disposable gloves, | • different antibiotics, like penicillin, sulfonamide etc. | | | |

PROCEDURE

- **Plate preparation:** A plate of Mueller-Hinton agar is inoculated with a standardized suspension of the bacteria being tested. This is done by swabbing the bacterial suspension evenly across the entire surface of the agar.
- **Disc placement:** Filter paper discs containing specific antibiotics are placed on the inoculated agar surface. These discs are spaced out to prevent the zones of inhibition from overlapping (24 mm apart).
- **Incubation:** The plates are incubated, typically at 35-37°C for 16 to 18 hours. During incubation, the antibiotic from each disc diffuses into the agar, creating a concentration gradient.



- **Measurement and interpretation:** After incubation, the diameter of the clear zone of inhibition around each disc is measured in millimeters. A larger zone means the antibiotic was more effective.
- **Classification:** The measured zone diameter is compared to determine if the bacteria is **susceptible (S)**, **intermediate (I)**, or **resistant (R)** to the antibiotic.

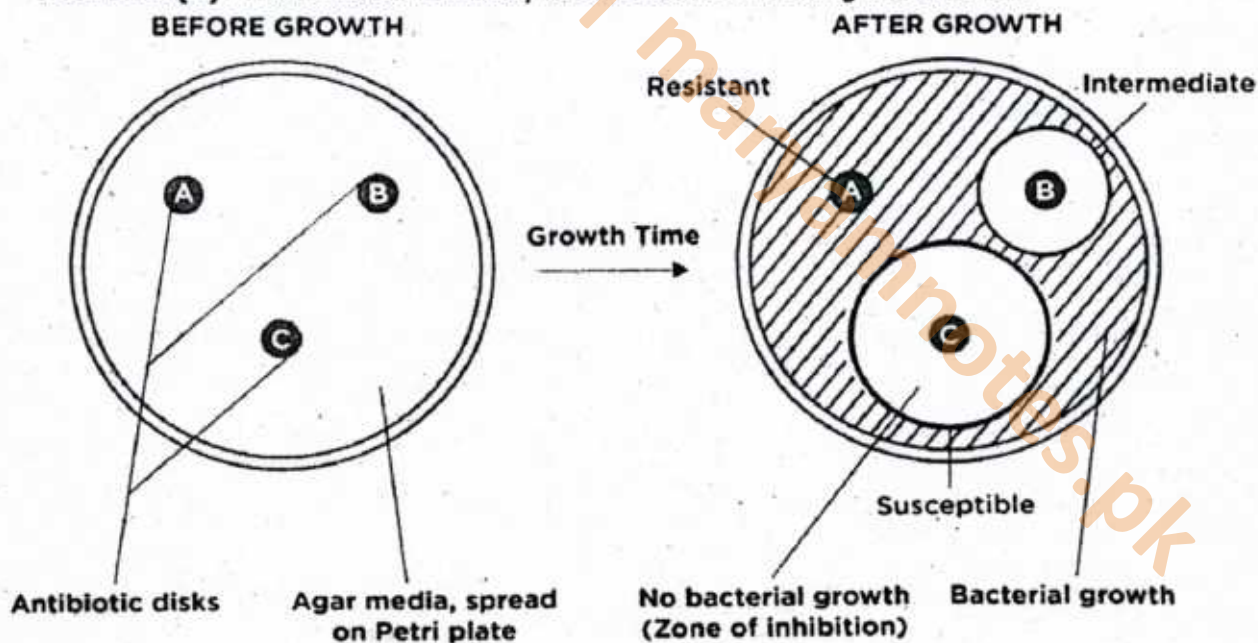


RESULTS

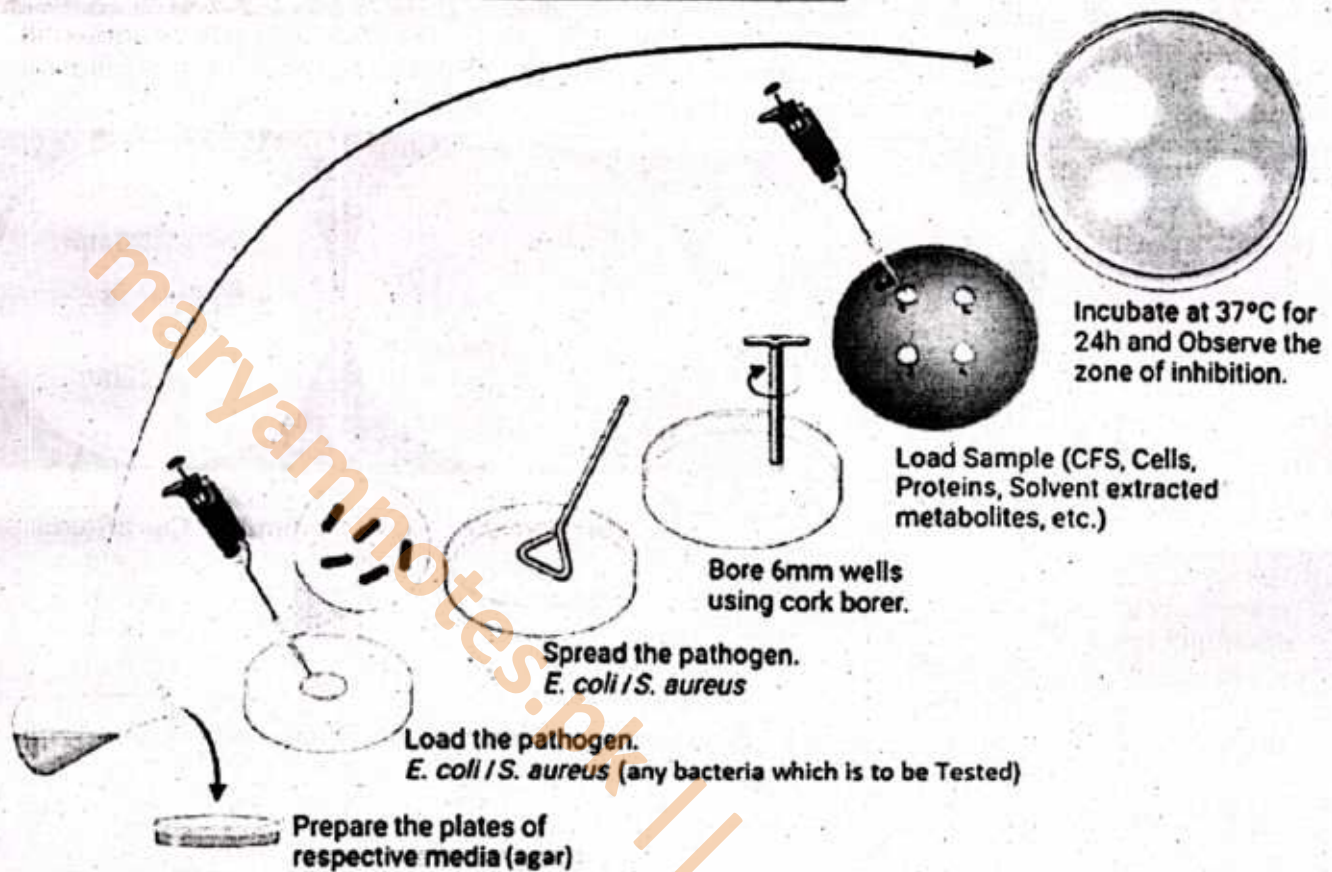
Susceptible (S): The antibiotic is likely to be effective in treating the infection.

Intermediate (I): The antibiotic may be less effective, and could potentially require a higher dose or be used in combination with another antibiotic.

Resistant (R): The antibiotic is unlikely to be effective in treating the infection.

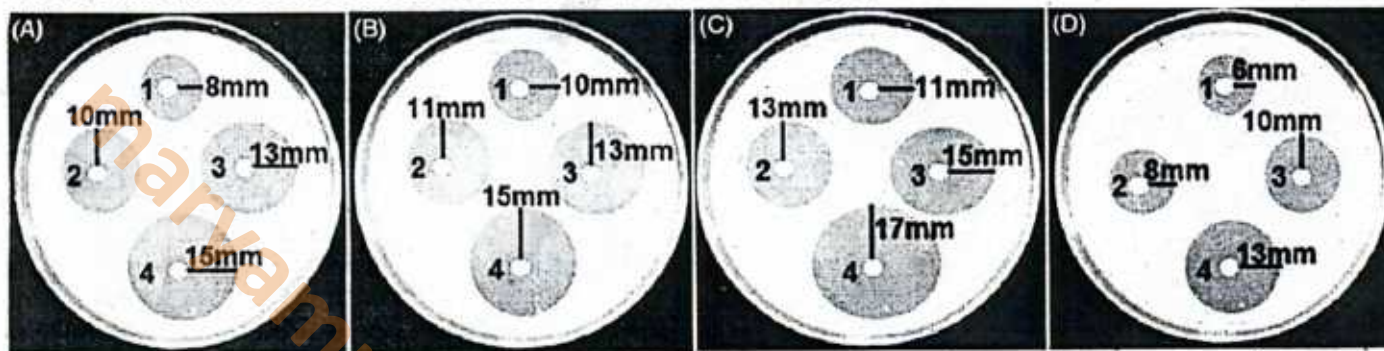


- Figure:**
- Disk A:** An ineffective antibiotic may not affect bacterial growth at all.
 - Disk B:** Antibiotics to which a bacterial isolate is partially susceptible will produce an intermediate size zone of inhibition.
 - Disk C:** An effective antibiotic will produce a large zone of inhibition.

Performance -II

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

A pharmacist is studying the effects of various antibiotics on various bacteria as shown in the Muller-Hinton agar plates. The observations are carefully tabulated as shown in the following table. Read and observe carefully and answer the following questions:



	1. Ampicillin	2. Tetracycline	3. Penicillin	4. Ciprofloxacin
A. E.coli	8 mm	10 mm	13 mm	15 mm
B. Pneumococcus	10 mm	11 mm	13 mm	15 mm
C. Salmonella typhi	11 mm	13 mm	15 mm	17 mm
D. Mycobacterium tuberculosis	06 mm	08 mm	10 mm	13 mm

i). Which two antibiotics seems to be more effective against pneumococcus and S.typhi? (1)

Ans:

ii). Which antibiotic will act as a broad spectrum antibiotic and why? (2)

Ans:

iii). Which bacteria is more resistant than others; justify your answer: (2)

Ans:

iv). Which reading seems to be anomalous? (1)

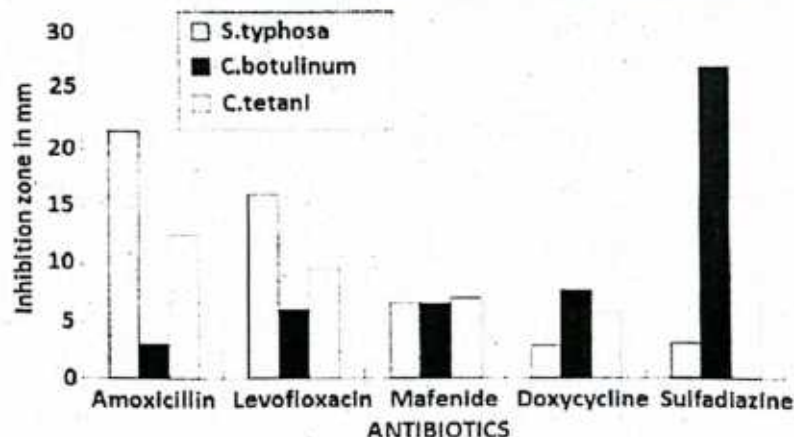
Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) Ciprofloxacin and Penicillin.
- (ii) Ciprofloxacin; because it is creating a large inhibition zone for all 4 types of bacteria
- (iii) E.coli; because it is not letting the inhibition zone broader than other bacteria.
- (iv) None

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

A pathologist is studying the effects of various antibiotics on various bacteria as shown in the Muller-Hinton agar plates. The data is shown in the following bar graph. Observe the graph carefully and answer the following questions:



- i). Which two antibiotics are more effective against *S.typhosa* and *C.botulinum*? (2)

Ans:

- ii). Which antibiotics are more susceptible (S) and intermediate (I) to bacteria. (2)

Ans:

- iii). Which bacteria is more resistance to doxycycline and amoxicillin than others; justify your answer: (1)

Ans:

- iv). Do you think any anomalous reading related to *C.botulinum*. (1)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- Amoxicillin and sulfadiazine
- Sulfadiazine; is more susceptible to *C.botulinum* and *C.tetani*.
Levofloxacin and amoxicillin are intermediate to *C.tetani*.
- S.typhosa* to doxycycline and *C.botulinum* to amoxicillin.
- Yes; Sulfadiazine seems to show anomalous reading as compared to against other bacteria.



ANALYSIS OF USE AND MISUSE OF SPECIFIC ANTIBIOTIC THROUGH PROVIDED DATA.

Antibiotics are used to treat bacterial infections, with appropriate uses including prescribed treatments for diagnosed bacterial illnesses and sometimes as a preventative measure before surgery. Misuses include taking them for viral infections like the common cold, not finishing the full course, using someone else's prescription, or obtaining them without a prescription. Misuse leads to antibiotic resistance, where bacteria evolve and become harder to treat, creating a major public health threat.

PROPER USES OF ANTIBIOTICS:

- **Treating bacterial infections:** Doctors prescribe antibiotics to cure infections caused by bacteria.
- **Preventing infection:** Antibiotics can be used to prevent infection, a practice known as prophylactic use, such as before a surgical procedure.
- **Targeting specific bacteria:** They can be used to target a wide range of infections (broad-spectrum) or only specific types (narrow-spectrum).

MISUSES AND CONSEQUENCES OF ANTIBIOTICS:

- **Taking antibiotics for viral infections:** Antibiotics are ineffective against viruses, which cause illnesses like the flu and common cold. Using them for these conditions does not help and contributes to resistance.
- **Not completing the full course:** Stopping an antibiotic early, even if you feel better, allows some bacteria to survive. These surviving bacteria can mutate and become resistant, making the infection harder to treat later.
- **Using leftover medication or someone else's prescription:** The leftover antibiotic may not be the right type or dosage for a current illness, and using it can lead to resistance and side effects.
- **Getting antibiotics without a prescription:** Obtaining antibiotics from a pharmacist or another source without a doctor's diagnosis can lead to using the wrong drug for the wrong infection.
- **Use in agriculture:** Overuse in livestock for growth promotion contributes to antibiotic resistance that can spread to humans through the food chain or environment.

CONSEQUENCES OF MISUSE:

- **Antibiotic resistance:** The most significant consequence is the development of antibiotic-resistant bacteria. These "superbugs" are more difficult to treat and can lead to more severe and even fatal infections.
- **Increased illness and death:** As antibiotics become less effective, infections can become more severe and potentially fatal.
- **Side effects:** Incorrect use can lead to side effects such as diarrhea, nausea, and yeast infections.

STATISTICAL ANALYSIS METHODS:

Statistical analysis of antibiotic use and misuse often involves using the **Defined Daily Dose (DDD)** methodology to quantify consumption and employing descriptive statistics and regression analyses to identify patterns and predictors of misuse.

Researchers use various statistical methods to analyze data related to antibiotic use and misuse:

- **Descriptive Statistics:** This involves calculating percentages, means, and frequencies to summarize the prevalence of antibiotic use, self-medication, and non-adherence to treatment regimens.
- **Regression Analysis:** This is used to identify significant associations between demographic factors (e.g., education level, income, gender) and inappropriate antibiotic practices. For instance, studies have found correlations between lower education levels and a higher likelihood of antibiotic misuse.
- **Odds Ratios (OR) and Confidence Intervals (CI):** These measures are used in meta-analyses and observational studies to quantify the strength of associations between different factors and the misuse of antibiotics. An OR > 1 suggests an increased likelihood of misuse with a particular factor.
- **Chi-squared (χ^2) tests:** These are applied to determine if there are significant associations between categorical variables, such as knowledge levels and self-medication practices.

Solved Numerical Examples (Case Study Snippets)

Numerical examples from studies demonstrate how data is quantified and interpreted:

1. Quantifying Antibiotic Consumption using DDD/100 Bed-Days

The World Health Organization (WHO) method for measuring antibiotic consumption in hospitals uses the **Defined Daily Dose (DDD)** per 100 **occupied bed-days (OBD)**.

Formula: $\text{DDD}/100 \text{ OBD} = (\text{Total antibiotic consumption in grams} / \text{WHO DDD in grams}) * 100 / \text{Total OBD}$.

Example: A study found the overall percentage of encounters where antibiotics were prescribed was 77%, which is high compared to the WHO standard of < 30%. The consumption of specific antibiotics showed considerable fluctuation, such as a drop to **96.02 DDD/100 BDs** in the last year of the study period.

2. Analyzing Prevalence of Misuse and Predictors

A study with 400 participants in Pakistan provided the following data points and analysis:

Prevalence: 119 participants (**29.8%**) purchased antibiotics without a prescription.

Non-adherence: **92.3%** (n=369) of respondents stopped taking the antibiotics when they felt better, even if they hadn't completed the full course.

Regression Result: A multiple linear regression analysis found that the *male gender* ($P=0.042$) and *knowledge scores* ($P<0.0005$) were significant predictors of attitude towards antibiotic use.

Interpretation: The statistically significant P-values indicate strong evidence that knowledge level and gender influence attitudes toward antibiotic use, suggesting targeted interventions could be beneficial.

3. Risk of Misuse by Demographic Factors

In a study of parents regarding their children's antibiotic use:

Data: 239 out of 410 respondents (**58.1%**) admitted to using antibiotics inappropriately.

Risk Association: Reduced education level increased the risk of antibiotic abuse:

RR (Relative Risk) = 0.7187 (95% CI 0.5915–0.8731, $p = 0.0009$).

(Note: $RR < 1$ here suggests higher education is a protective factor, lowering misuse risk).

Interpretation: The significant p-value (< 0.05) and confidence interval demonstrate a robust association between lower education levels and a higher probability of misusing antibiotics.



DATA ANALYSIS AND STATISTICAL APPROACH TO DIFFERENT EXPERIMENTS

DATA ANALYSIS

FREQUENCY:

It is the number of times a particular data value or event occurs within a dataset.

Cumulative frequency:

The running total of the frequencies. The cumulative frequency for a value is the sum of its frequency and the frequencies of all preceding values.

Class (no. of flowers/plant)	Frequency (no. of plants = n)	Cumulative frequency
1	30	30
2	50	80
3	60	140
4	40	180
5	30	210

PERCENTAGES: "Per cent" means per hundred, so a percentage describes a proportion of 100.

To calculate a percentage, divide the number of items or patients in the category by the total number in the group and multiply by 100.

Example: Data were collected on 80 patients referred for heart transplantation. The researcher wanted to compare their ages. The data for age were put in "decade bands" and are shown in Table 1.

Table 1. Ages of 80 patients referred for heart transplantation

Years ^a	Frequency ^b	Percentage ^c
0-9	2	2.5
10-19	5	6.25
20-29	6	7.5
30-39	14	17.5
40-49	21	26.25
50-59	20	25
≥ 60	12	15
Total	80	100

^aYears = decade bands;

^bFrequency = number of patients referred;

^cPercentage = percentage of patients in each decade band.

For example, in the 30-39 age band there were 14 patients and we know the ages of 80 patients, so $14 / 80 \times 100 = 17.5\%$.

RANGE:

The range is a simple measure of the spread of data. It is calculated by subtracting the smallest value in the dataset from the largest value.

For example, in the dataset {2,4,5,7,8}, the range is $8 - 2 = 6$.

MEAN:

Otherwise known as an arithmetic mean, or average.

The mean is the sum of all the values, divided by the number of values.

Example 1: Five women in a study on lipid-lowering agents are aged 52, 55, 56, 58 and 59 years. Add these ages together: $52 + 55 + 56 + 58 + 59 = 280$ Now divide by the number of women:

$$280/5 = 56$$

Example 2: Sample Mean ($\bar{x}$) for grouped / tabulated data: $\bar{x} = \sum fx / \sum f$

Minutes Late	Frequency, f	Midpoint (x)	fx
0 - 10	27	5	135
10 - 20	10	15	150
20 - 30	7	25	175
30 - 40	5	35	175
40 - 50	4	45	180
50 - 60	2	55	110

$$\sum f = 55$$

$$\sum fx = 925$$

$$\text{Mean estimate} = 925/55 = 16.8 \text{ minutes}$$

MEDIAN:

Sometimes known as the mid-point.

It is the point which has half the values above, and half below.

Example 1: Using the above first example (Odd number) of five patients aged 52, 55, 56, 58 and 59, the median age is 56, the same as the mean – half the women are older, half are younger.

Example 2: However, in the second example (Even number) with six patients aged 52, 55, 56, 58, 59 and 92 years, there are two "middle" ages, 56 and 58. The median is halfway between these, i.e. 57 years. This gives a better idea of the mid-point of this skewed data than the mean of 62.

MODE:

The mode is the most common of a set of events. OR

The value that appears most frequently in the dataset.

Example 1: An eye clinic sister noted the eye-colour of 100 consecutive patients. The results are shown in Fig. 4.

An eye clinic sister noted the eye-colour of 100 consecutive patients. The results are shown in Fig. 4.

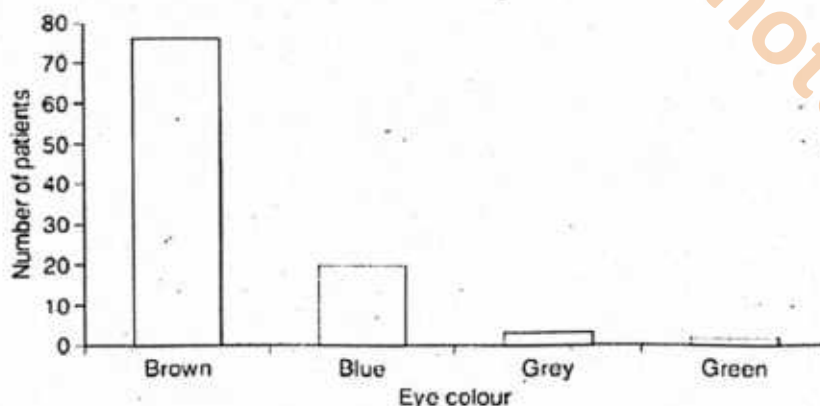


Fig. 4. Graph of eye colour of patients attending an eye clinic.

In this case the mode is brown, the commonest eye colour.

Example 2: In the given ungrouped data: 2,3,4,4,5,6,6,6,7,8. Mode will be 6.

	MEAN	MEDIAN	MODE
Definition	Mean is the sum of all the values of data set divided by the total number of values in the data set.	The median is the middle value in a dataset that are arranged in ascending or descending order of magnitude.	The mode is the value in a dataset that appears maximum number of times.
Formulae	<u>For Un-Group Data</u> $\bar{x} = \frac{\sum x}{n}$ <u>For Group Data</u> $\bar{x} = \frac{\sum fx}{\sum f}$	<u>For the Dataset with Odd Number of Values</u> $\text{Median } (\bar{x}) = \left(\frac{n+1}{2}\right)^{\text{th}}$ <u>For the Dataset with Even Number of Values</u> $\text{Median } (\bar{x}) = \frac{\left(\frac{n}{2}\text{th value}\right) + \left(\frac{n}{2} + 1\right)}{2}$	Mode $(\bar{x}) = l + \left[\frac{(f_m - f_1) \times h}{(f_m - f_1) + (f_m - f_2)} \right]$
Examples	Sum the values: $\sum x = 2+3+4+4+5+6+6+7+8 = 51$, $n = 10$, $\bar{x} = 51/10 = 5.1$	2,3,4,4,5,6,6,6,7, $n=9$, $(9+1/2)=5^{\text{th}}$ term 5 will be the median,	

STANDARD DEVIATION (S/σ): SD indicates how much a set of values is spread around the average.

A range of one SD above and below the mean (abbreviated to ± 1 SD) includes 68.2% of the values.

± 2 SD includes 95.4% of the data.

± 3 SD includes 99.7%.

$$S \text{ or } \sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Example 1: Let us say that a group of patients enrolling for a trial had a normal distribution for weight. The mean weight of patients was 80 kg. For this group, SD was calculated to be 5 kg.

1 SD below the average is $80 - 5 = 75$ kg.

1 SD above the average is $80 + 5 = 85$ kg.

± 1 SD will include 68.2% of the subjects, so 68.2% of patients will weigh between 75 & 85 kg.

95.4% will weigh between 70 and 90 kg (± 2 SD).

99.7% of patients will weigh between 65 and 95 kg (± 3 SD).

See how this relates to the graph of the data in the following Figure.

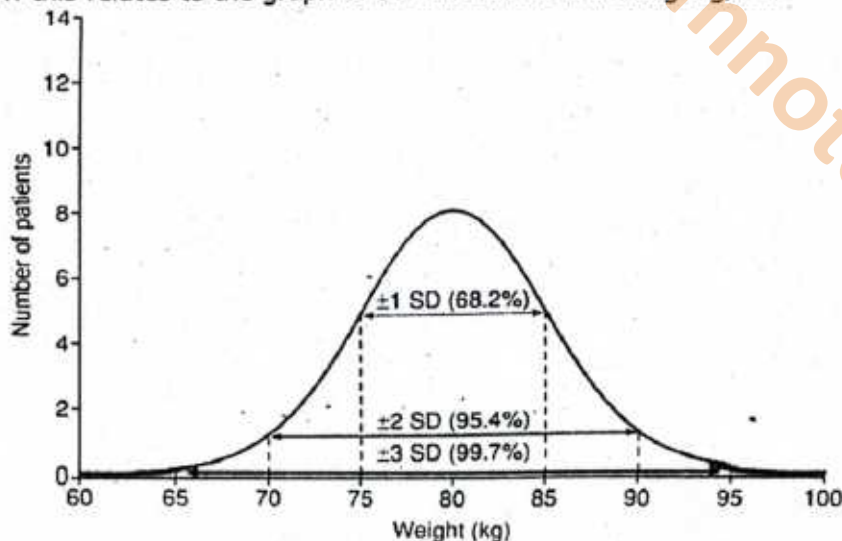


Figure: Graph showing normal distribution of weights of patients enrolling in a trial with mean 80 kg, SD 5kg.

VARIANCE (S^2/σ^2): Variance is a statistical measure of how spread out a set of numbers is from their average (mean). It is calculated by squaring the difference between each data point and the mean, then finding the average of those squared differences. A low variance indicates that the data points are close to the mean, while a high variance shows that the data points are widely dispersed.

$$\sigma^2 = \frac{\sum (x - \bar{x})^2}{n - 1}$$

STANDARD ERROR: Standard error (SE) is a statistic that measures how much the means of different samples are likely to vary from the true population mean. It is calculated by dividing the sample standard deviation (s) by the square root of the sample size (n):

$$\text{Standard error} = \frac{s}{\sqrt{n}}$$

STANDARD DEVIATION	RANGE
Standard Deviation measures how much the individual data points deviate from the mean (average). It takes into account all data points, providing a more accurate picture of variability, especially when outliers are present.	Range is the difference between the maximum and minimum values in a data set. It gives a simple measure of how spread out the values are but it is sensitive to extreme values (outliers).

PERCENTILE: Percentiles divide a dataset into 100 parts. The p th percentile is the value below which $p\%$ of data falls. **For instance**, the 75th percentile is the value below which 75% of the data lies. To find the 80th percentile of a dataset with 70 values, you would first sort the data, then calculate the index $i = (80/100) * 70 = 56$. Since i is an integer, you would average the 56th and 57th values in the sorted data to find the 80th percentile.

VARIABLES: Variables in statistics are characteristics that can be measured or counted and can have different values, such as height or eye color. Here we discuss **various types of variable**:

	Independent Variable (IV)	Dependent Variables (DV)	Controlled Variables (CV)
Definition	The variable that is changed or controlled in an experiment to test its effects on the dependent variable. It is the " cause " and does not depend on other variables	Dependent variable is the " effect ," which is measured and is expected to change in response to the independent variable.	CV are factors kept constant in an experiment or study to ensure they don't influence the relationship between the independent and dependent variables.
Examples	1: Investigating effect of temperature on plant growth. IV: Temperature (the cause). DV: Plant growth (the effect). 2: Determining if a new drug is effective at controlling high blood pressure. IV: The new drug (the cause). DV: Blood pressure levels (the effect). 3: Examining if drinking coffee improves alertness. IV: Coffee consumption (the cause). DV: Alertness (the effect).		keeping the temperature and amount of water constant when testing the effect of different fertilizers on plant growth, or controlling for participant age and noise levels when testing caffeine's effect on memory.

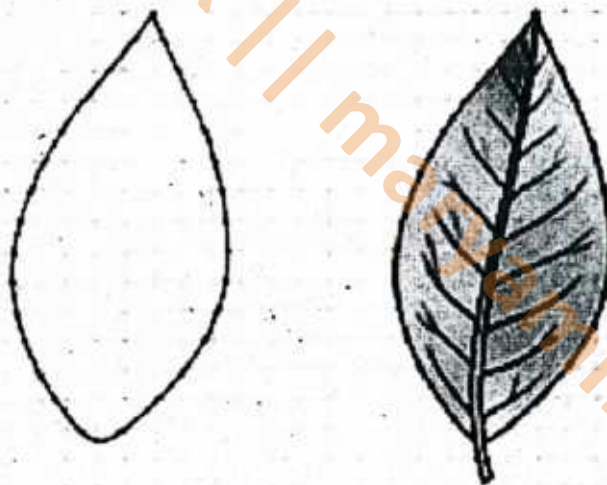
(A) MEASURING VARIABILITY IN LEAF SURFACE AREA BY GRAPH PAPER METHOD (PALNIMETRY) USING DIFFERENT PLANT SPECIES.

APPARATUS AND CHEMICALS

- Leaves of different plants,
- Erasers
- Lead pencil
- Graph paper of small box size 1 cm^2
- Rulers

PROCEDURE

- First of all take a leaf.
- Place the leaf on a graph sheet and draw the outline of the leaf with a pencil (as shown in Figure).
- Remove the leaf. You can see the outline of the leaf on the graph sheet.
- Now, count the number of whole squares enclosed within the outline of the leaf. Take it to be **C**.
- Then, count the number of squares that are more than half. Take it as **M**.
- Next, count the number of squares which are half of a whole square. Note it to be **H**.
- 1 Square = 1 cm^2
- Finally, count the number of squares that are less than half. Let it be **Q**.



Calculations

$$C=51$$

$$M=15$$

$$H=4$$

$$Q=11$$

Now, the approximate area of the leaf can be calculated using the following formula:

$$\begin{aligned} \text{Approximate area of the leaf} &= C + \left(\frac{3}{4}\right) M + \left(\frac{1}{2}\right) H + \left(\frac{1}{4}\right) Q \text{ square cm.} \\ \text{Area of the leaf} &= 51 + \left(\frac{3}{4}\right) \times 15 + \left(\frac{1}{2}\right) \times 4 + \left(\frac{1}{4}\right) \times 11 \\ &= 51 + 11.25 + 2 + 2.75 = 67 \text{ cm}^2. \end{aligned}$$

This formula can be used to calculate the area of any irregularly shaped plane figures:

(B) DETERMINATION OF HUMAN HEIGHT OR WEIGHT VARIABILITY AMONG STUDENTS OF SAME AGE GROUP (FOR EXAMPLE HSSC STUDENTS.)

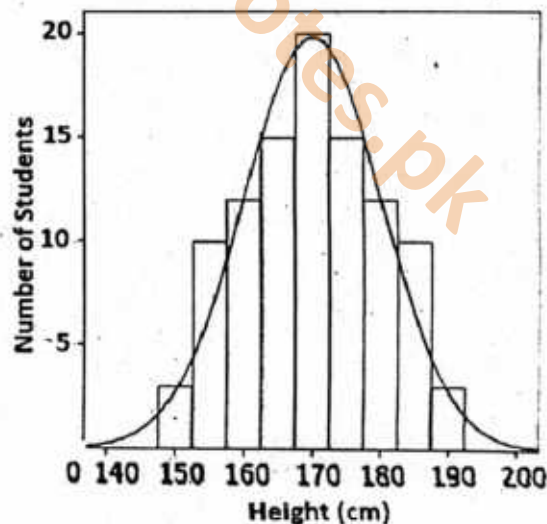
APPARATUS

- Students data,
- Lead pencil
- Rulers/ 2 m measuring Tape/ stadiometer
- Erasers
- Weight machine
- Graph paper of small box size 1 cm²

PROCEDURE

1. **Prepare:**
Find a flat wall and floor. Take off your shoes and any bulky clothing or hair accessories.
2. **Mark your height:**
Stand with your back flat against the wall, making sure your heels, back, shoulders, and head are all touching the wall. Have a helper hold a flat, straight object (like a book or ruler) on top of your head, ensuring it's level. Mark the wall at the bottom edge of the object with a pencil.
3. **Measure the mark:**
Step away from the wall. Use a common object of a known length, such as a ruler, book, or piece of paper, to measure the distance from the floor to your mark.
4. **Weight Measurement:**
As the height of student is marked then the each same student is asked to measure his/her weight.
5. **Data collection:**
All the students will follow the above procedure. Finally a data is collected in the form of a table as shown in the following table in numerical questions.
6. **Data arrangement:**
Data is arranged in the ascending order for height and weight separately.
7. **Plotting a Bar graph:**
A bar graph is plotted by taking height and weight on X-axis and number of students on Y-axis.

Sr. Number	Number of Students	Height (cm)	Weight (Kg)
1	3	150	55
2	10	155	60
3	12	160	52
4	15	165	65
5	20	170	58
6	15	175	62
7	12	180	57
8	10	185	62
9	3	190	70



(C) COMPARING THE INCREASE IN PLANT HEIGHTS IN DIFFERENT SOIL TYPES (HAVING DIFFERENT CONCENTRATIONS OF MINERALS (E.G., N, P, K)

All autotrophic organisms need carbon dioxide and water, which supply **carbon, oxygen and hydrogen**. These are the predominant elements which serve as **Inorganic Nutrients** and are required by plants for the synthesis of organic molecules. There are many other inorganic nutrients that plants get from environment.

These are of 2 main types according to the need of body i.e, macronutrients and micronutrients.

MACRONUTRIENTS		
ELEMENTS	MAJOR FUNCTIONS	EARLY VISUAL SYMPTOMS OF NUTRIENT DEFICIENCIES
PRIMARY MACRONUTRIENTS		
Nitrogen (NO_3^- , NH_4^+)	• Component of Nucleic Acids (essential role in energy-ATP metabolism), • Proteins production, and • Chlorophyll synthesis • Plant assimilates nitrogen in the form of nitrate.	• Leaf loss and • Stunted growth. • Chlorosis
Phosphorus (H_2PO_4^- , HPO_4^{2-})	Component of nucleic acids, phospholipids, ATP etc. • Promoting root growth • Favours flowering in the aerial zone. • Role in the transportation and storage of energy.	• Delayed flowering, as well as the • Browning & wrinkling of leaves. • Stunted growth in Roots
Potassium (K^+)	• Water regulation and the transportation of plant's reserve substances. • Enhances ability of plants to do photosynthesis • Reinforces cellular tissue, and • Stimulates the uptake of nitrates.	• Dark patches form on the leaves

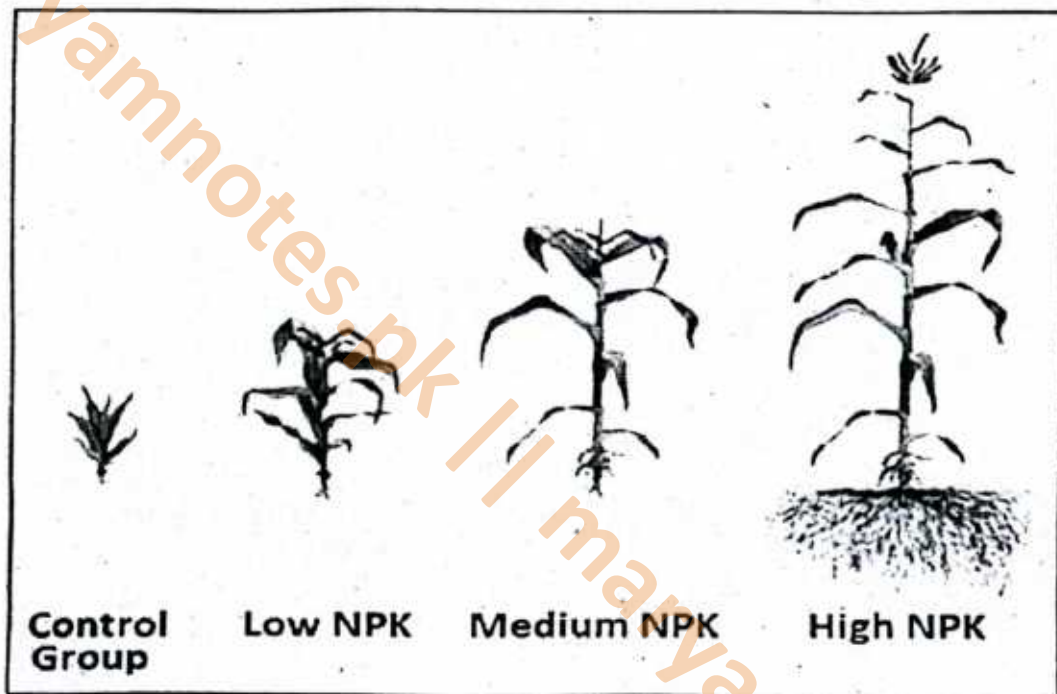
APPARATUS AND MATERIALS

- Measuring tape or ruler
- Labels/markers
- Soil used same for all plants under experimentation
- Seeds of a uniform plant type (e.g., maize, tomato, , or a fast-growing leafy green plant)
- NPK fertilizer formulations (e.g., 15-15-15 or specific ratios of N, P, and K)
- Watering can
- Plant pots

PROCEDURE

- 1. Preparation of soil in plant pots:** Use the same type of plants for all experiments ensuring its age, size and species.
- 2. Preparation of Seedlings:** Use the same type of soil for all experimental plants ensuring its consistency regarding water contents and initial nutrient composition.
- 3. Preparation of NPK Fertilizers Formulations:** Apply different formulations of NPK fertilizers to various groups of plant as shown in the following table.
- 4. NPK Fertilizers Application:** Now Apply the fertilizer according to the manufacturer's instructions or a standardized protocol. Ensure even distribution around the base of each plant.

5. **Growth Conditions:** Always maintain consistent environmental conditions for all plants, including watering, sunlight exposure, and temperature.
6. **Measurements:**
Regularly measure the height of each plant (e.g., weekly) using a ruler or measuring tape, starting from the soil surface to the tip of the tallest leaf or stem.
7. **Data Collection and Analysis:**
Record the height measurements for each plant group and calculate the average height for each treatment group at each time point. Compare the average height of the treated groups with the control group to determine the impact of NPK on plant height. Statistical analysis (e.g., ANOVA) can be used to determine if the differences in height are significant.



RESULTS

NPK Fertilizers Formulations and application		RESULTS (2 Months)
Control Group	No NPK fertilizer added	slowest growth rate. shortest height compared to the other groups
Low NPK	A low concentration or a balanced NPK ratio (e.g., 10-10-10).	increased plant height compared to the control group
Medium NPK	A medium concentration or a balanced NPK ratio (e.g., 20-20-20).	increased plant height compared to the Low NPK group
High NPK	A high concentration or a balanced NPK ratio (e.g., 30-30-30).	increased plant height compared to Medium NPK group
High N	A high nitrogen ratio (e.g., 30-10-10).	Good height but stunted root growth
High P	A high phosphorus ratio (e.g., 10-30-10).	medium height but good root growth
High K	A high potassium ratio (e.g., 10-10-30).	Medium height but stunted root growth

(D) TO INVESTIGATE THE EFFECT OF THE AMOUNT OF FERTILIZER USED ON PLANT GROWTH (HEIGHT AND NUMBER OF LEAVES)

APPARATUS AND MATERIALS

- Measuring tape or ruler
- Plant pots
- Seeds of a uniform plant type (e.g., maize, tomato, or a fast-growing leafy green plant)
- NPK fertilizer formulations (e.g., 0g, 5g, 10g, 15, 20g)
- Watering can
- Soil used same for all plants under experimentation
- Labels/markers

PROCEDURE

- 1. Preparation of soil in plant pots:** Use the same type of plants for all experiments ensuring its age, size and species.
- 2. Preparation of Seedlings:** Use the same type of soil for all experimental plants ensuring its consistency regarding water contents and initial nutrient composition.
- 3. Preparation of NPK Fertilizers Formulations:** Apply different formulations of NPK fertilizers to various groups of plant as shown in the following table.
- 4. NPK Fertilizers Application:** Now Apply the fertilizer according to the manufacturer's instructions or a standardized protocol. Ensure even distribution around the base of each plant.
- 5. Growth Conditions:** Always maintain consistent environmental conditions for all plants, including watering, sunlight exposure, and temperature.
- 6. Measurements:** Regularly measure the height of each plant (e.g., weekly) using a ruler or measuring tape, starting from the soil surface to the tip of the tallest leaf or stem and count the number of leaves of each plant
- 7. Data Collection and Analysis:** Record the height measurements and number of leaves for each plant group and calculate the average height and number of leaves for each treatment group. Compare the average height and number of leaves of the treated groups with the control group to determine the impact of amount of NPK Fertilizer on plant height and leaves. Statistical analysis (e.g., ANOVA) can be used to determine if the differences in height and number of leaves are significant.



Control NPK 5g NPK 10g NPK 15g
Watch the height & number of leaves in plants after 2 months

RESULTS

NPK Fertilizers application		RESULTS (2 Months)	
Control Group	• No NPK fertilizer added	Height = 10 cm	Number of leaves = 15
5g NPK	• 5 g NPK was added	Height = 20 cm	Number of leaves = 25
10g NPK	• 10 g NPK was added	Height = 30 cm	Number of leaves = 35
15g NPK	• 15 g NPK was added	Height = 40 cm	Number of leaves = 50

(E) TO INVESTIGATE THE EFFECT OF TEMPERATURE AND pH ON ENZYME ACTIVITY

Kindly see the practicals 1-A and 1-B.

(F) TO INVESTIGATE THE EFFECT OF LIGHT INTENSITY ON PLANT GROWTH (HEIGHT AND NUMBER OF LEAVES)

APPARATUS AND MATERIALS

- Measuring tape or ruler
- Plant pots
- Light source/ LED bulb or sun
- Watering can
- Soil used same for all plants under experimentation
- various shades
- Labels/markers

PROCEDURE

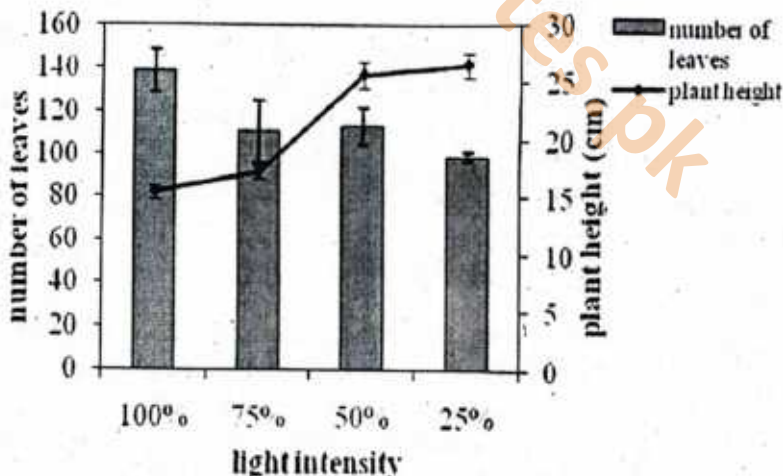
- 1. Preparation:** Plant several seeds in each of the pots to ensure a good selection of healthy seedlings. Once germinated and a few inches tall, select a set of uniform seedlings for the experiment, ensuring all are roughly the same height and have the same number of leaves.
- 2. Set Up Different Light Conditions:**
 - i. High Light:** Place one plant in a location with abundant light (e.g., a sunny windowsill or 10-20 cm from the light source).
 - ii. Medium Light (Optional):** Place another plant at an intermediate distance from the light source (e.g., 40-50 cm away) or under a moderate shade net.
 - iii. Low Light/Dark:** Place a third plant in a dark cupboard or cover it completely with a box to block out most light.
- 3. Control Variables:** Water all plants with the same amount of water at the same time intervals. Ensure the temperature is consistent across all locations, especially if using a lamp that produces heat.
- 4. Observation and Data Collection:** Measure and record the height of each plant (from the soil line to the top of the tallest part) and count the number of new leaves every 1-2 days.
- 5. Duration:** Continue the observations for a period of **2-4 weeks**. The effects should become visibly apparent within this timeframe.
- 6. Analysis:** Record the results in a table and plot a graph of plant height/number of leaves against the light intensity/distance from the light source.

RESULTS

Height: Plants in low light will likely be taller (etiolation) as they stretch to find a light source, but their stems will be weak and thin. Plants in optimal or high light will be shorter and more compact with thicker stems.

Number of Leaves: Generally, the number of leaves and total biomass tend to be higher in optimal to high light intensities compared to very low light conditions.

Leaf Color: Plants in light will be green due to chlorophyll production, while those in the dark will appear pale or yellow (chlorosis).



(G) TO INVESTIGATE THE EFFECT OF LIGHT INTENSITY ON THE RATE OF PHOTOSYNTHESIS

Performance-1

APPARATUS AND MATERIALS

- Large beaker (250 cm³)
- Funnel
- Boiling/Test tube
- Sodium hydrogen carbonate
- Water tank
- Stopwatch
- Lamp/light source
- Metre ruler
-
- Aquatic plant (Pondweed), e.g. *Elodea*/Hydrilla (approx 8 cm length)

PROCEDURE

1. Set up Preparation:

Fill the beaker or test tube with water and add a small amount of sodium hydrogen carbonate solution to provide a source of carbon dioxide.

Submerge the aquatic plant in the solution, ensuring it is fully immersed.

2. Control Variables:

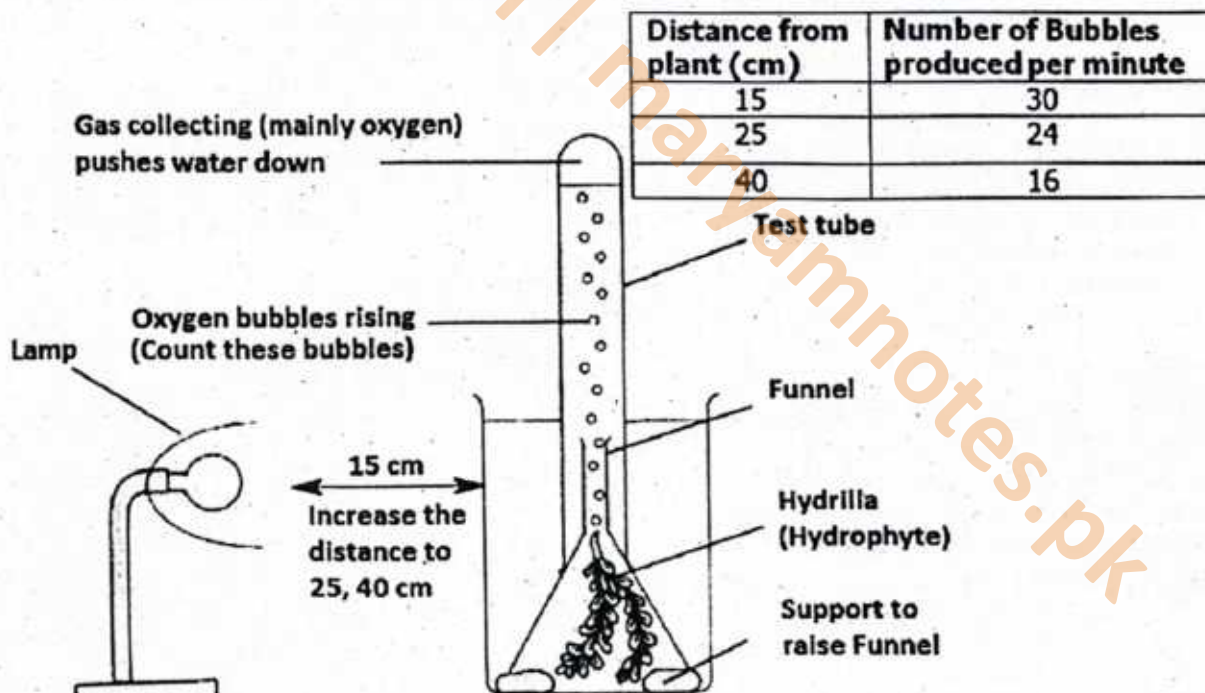
Maintain a constant temperature using a water bath or by placing a glass tank between the light source and the plant to absorb heat.

Keep the concentration of carbon dioxide constant by using the same amount of sodium hydrogen carbonate solution in each test.

3. Vary Light Intensity:

Place the light source at a specific distance from the plant (e.g., 10 cm).

Allow the plant to adjust to the new light intensity for a few minutes (e.g., 5 minutes).



Procedure: Set up the apparatus like diagram; i. place lamp from plant at distance of 15 cm for 15 minutes and count the bubbles.

ii. Now place the lamp at 25 cm for 15 minutes and count the bubbles.

iii. same procedure at 40 cm distance:

Record observations in tabular form

4. Measure Photosynthesis Rate:

Start the stopwatch and count the number of oxygen bubbles released from the plant over a set time period (e.g., one minute).

Repeat the bubble count multiple times (e.g., 3-5 times) at each distance and calculate the average.

5. Repeat for Different Light Intensities:

Move the light source to different distances from the plant (e.g., 20 cm, 30 cm, etc.).

Repeat steps 3 and 4 for each distance to obtain data for different light intensities.

6. Data Analysis:

Calculate the rate of photosynthesis by dividing the average number of bubbles by the time period.

Plot the data on a graph with light intensity on the x-axis and rate of photosynthesis on the y-axis

Variables:

- Independent Variable (IV):**

Light intensity (controlled by shading or distance from light source). You'll need to establish different levels of light intensity, such as low, medium, and high.

- Dependent Variables (DV):**

Oxygen evolution and rate of photosynthesis.

- Controlled Variables (CV):**

Type of plant (use the same species), growing medium, watering frequency, temperature, and nutrient availability.

Calculating light intensity:

Light intensity can be calculated using this formula.

$$\text{Light intensity} \propto 1/\text{Distance}^2$$

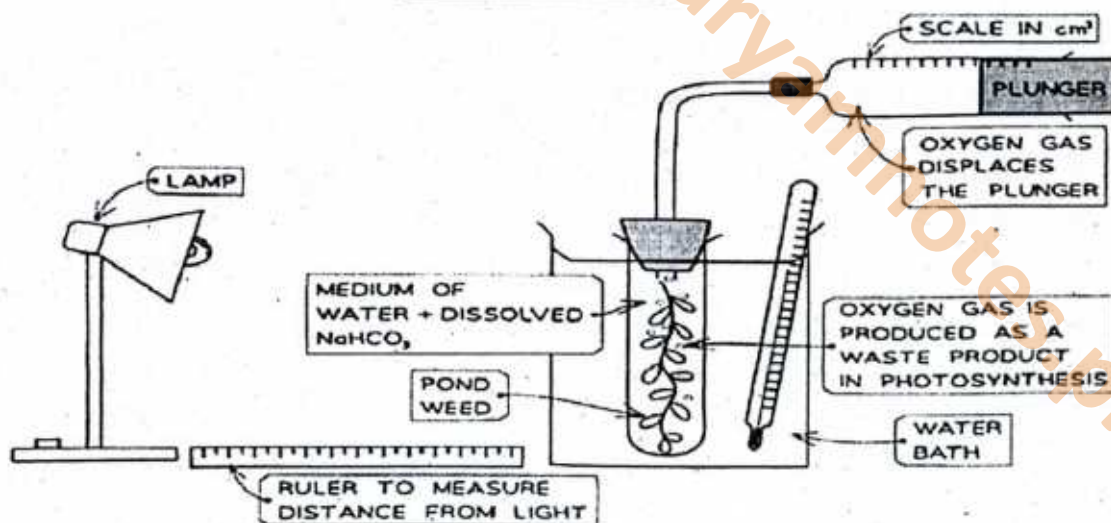
The symbol $\propto$ means 'is proportional to', and distance is measured in metres.

Therefore, when the light is 20 cm (0.2 m) from the plant, it will receive

$$1/(0.2)^2 \text{ m}^2 = 1/0.04 \text{ m}^2 = 25 \text{ arbitrary units}$$

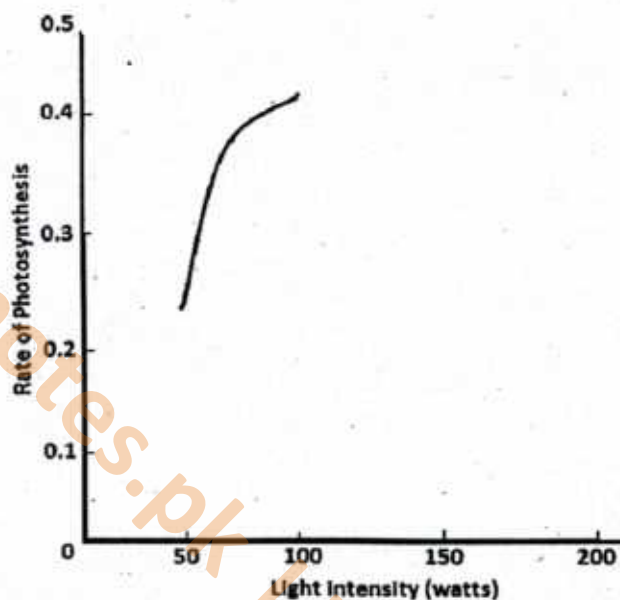
But when the light is 40 cm (0.4 m) from the plant, it will only receive

$$1/(0.4)^2 \text{ m}^2 = 1/0.16 \text{ m}^2 = 6.25 \text{ arbitrary units}$$

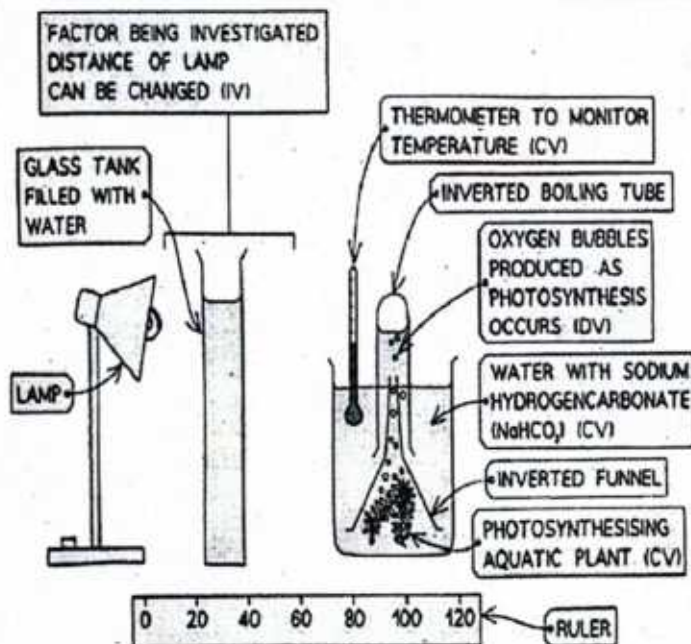
Performance-2

Procedure: Do not change the distance between Lamp and pond weed; instead change the voltage of lamp bulb like 45 watts, 75 watts, 150 watts. Plunger will be displaced due to oxygen. Calculate the time as the plunger collects 1 ml of oxygen at each intensity of lamp bulb. Record your observations in the form of table and calculate the rate of photosynthesis at different intensities of light.

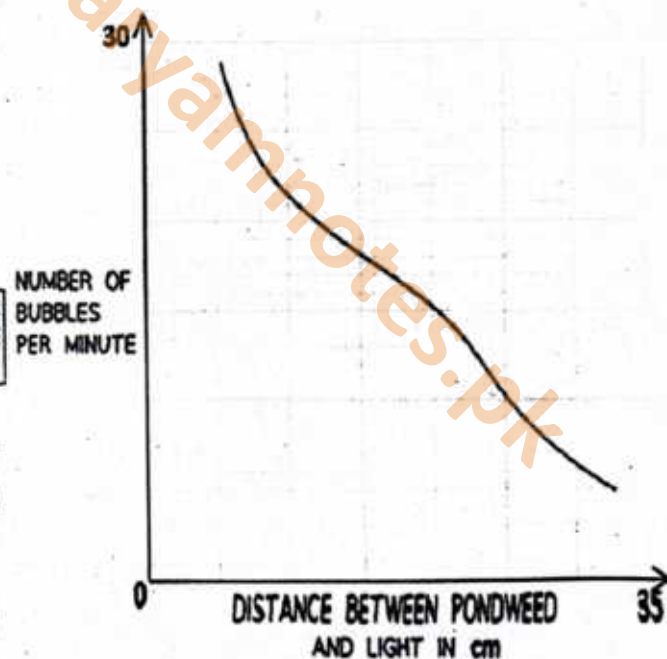
Light intensity in watts	O ₂ evolved in ml	Elapsed time (min + sec)	Elapsed time in minutes	Rate of photosynthesis (ml O ₂ /hr) = $0.1/\text{time (min)} \times 60/1\text{hr}$
50	0.1	25 min+15 sec	25.25	$0.1/25.25 \times 60 = 0.24$
75	0.1	16 min+30 sec	16.5	0.37
100	0.1	14 min+45 sec	14.75	0.41



Performance-3



Distance of lamp can be changed i.e, 15 cm, 20 cm, 25 cm, 30 cm, 35 cm, 40 cm. Count the number of bubbles at each changing distance and record the observation:



(H) TO INVESTIGATE THE EFFECT OF DIFFERENT AMOUNTS OF WATER IN SOIL ON PLANT GROWTH (HEIGHT AND NUMBER OF LEAVES)

APPARATUS AND MATERIALS

- Six small plant pots
- Labels
- Six young, healthy seedlings of the same species and size (e.g., bean or radish plants work well and grow quickly).
- Soil
- Metre ruler
- Tap water (same consistency)

PROCEDURE

1. **Set up the Pots:**
 - Fill all six pots with an equal amount of potting soil.
 - Plant one seedling in each pot at the same depth.
2. **Label the Groups:**
 - Divide the pots into three groups of two. Label the groups:
Group A: "Low Water" Group B: "Medium Water" (Optimal) Group C: "High Water" (Excessive)
- **Control Variables:**
Place all pots in the same location to ensure they receive the same amount of sunlight and are exposed to the same temperature. Use the same type of soil and the same type/size of pots for all plants.
3. **Implement Watering Schedule (Independent Variable):**
Water the plants at the same time each day (or on a set schedule). The amount of water is your independent variable.
Group A (Low Water): Provide a small, fixed amount of water (e.g., 25 ml).
Group B (Medium Water): Provide a moderate, fixed amount of water that keeps the soil moist but not saturated (e.g., 75 ml). The goal is to find the optimal range.
Group C (High Water): Provide a large, fixed amount of water (e.g., 150 ml), keeping the soil consistently saturated to test the effects of overwatering.
4. **Record Observations (Dependent Variables):**
 - Measure the height of each plant (from the soil level to the tip of the tallest shoot) every 2-3 days and record the data.
 - Count and record the number of leaves on each plant periodically.
 - Note any other observations, such as leaf color (e.g., yellowing), wilting, or overall health.

RESULTS

Over a period of 2 to 3 weeks, you should observe:

Height & Leaves: Plants in the "Medium Water" group will likely show optimal growth, with significantly higher height and more leaves compared to the other groups.

Low Water: Plants in this group will likely exhibit stunted growth, possibly wilting, smaller leaves, and a decrease in leaf mass.

High Water: Plants in this group might show yellowing leaves, signs of root rot (due to lack of oxygen in saturated soil), and inhibited growth, potentially even death.

Samples	Stem Height (cm)					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
A	0.3	0.6	0.9	1.3	1.7	2.1
B	1.01	2.14	4.12	4.92	7.89	8.52
C	0.1	0.2	0.3	0.3	0.3	0.3

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

A scientist was working on effect of various wavelengths and intensities of light on plants to find out rate of photosynthesis. He found the following dataset of rate of photosynthesis i.e, 12, 13, 30, 32, 49, 54, 72, 72, 80, 87. Using his data Show your calculations and readings to find:

i): Calculate the Mean and median of rate of photosynthesis: (1)

Ans: _____

ii): What would be the Mode and range for the given data set? (1)

Ans: _____

iii): What would be the independent and dependent variables in the experiments? (2)

Ans: _____

iv): Derive standard deviation and variance for the given data. (2)

Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

An agronomist was experimenting on growth of same species of plants in the same soil provided with different types of fertilizers containing N, P, K, S, Fe. He found the following dataset of heights (in cm) in plants growth after 2 months i.e, 4, 7, 9, 10, 10, 13, 15. Using his data Show your calculations and readings to find:

i): Calculate the Mean and median for plant heights: (2)

Ans: _____

ii): What would be the Mode and range for the given data set? (2)

Ans: _____

iii): Derive standard deviation for the given data. (1)

Ans: _____

iv): Derive variance for the given data. (1)

Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3

A sample dataset of heights (in cm) from 10 female students, all aged 16 years, are 150, 165, 172, 149, 155, 159, 160, 152, 155, 163. Show your calculations and readings to find:

i): **Derive standard deviation for the heights of female students.** (1)

Ans: _____

ii): **Calculate that How spread out a set of numbers is from its average (mean).** (1)

Ans: _____

iii): **Measure how accurately a sample mean estimates a population mean?** (2)

Ans: _____

iv): **Calculate the Mean and median for the heights of female students.** (2)

Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 4

Heights (in cm) of 9 male students, all aged 18 years, were measured. The heights of 9 male students (in cm) are: 176, 160, 163, 157, 168, 172, 173, 169, 165. Show your calculations and readings to find:

i): **Find out the Median value in the above heights of students.** (2)

Ans: _____

ii): **Calculate standard deviation for the above dataset.** (2)

Ans: _____

iii): **Derive variance for the given data of students.** (1)

Ans: _____

iv): **Measure how accurately a sample mean estimates a population mean?** (1)

Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 5

A dicot Bifacial Leaf, graph paper is provided to a student by an examiner. Student is asked to calculate its surface area:

- i). Enlist the steps followed by the student. (3)

Ans: _____

- ii). Which types of squares will be faced by students and how their correct counting can be done. (2)

Ans: _____

- iii). After counting the squares, which formula will be applied to calculate the size of leaf: (1)

Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 6

- i). Calculate the median of the values given in dataset of above question 13. (1)

Data Given: 33, 55, 66, 84, 91, 72, 68, 87, 78, 66, 82, 46, 71, 31, 38

Ans: _____

- ii). Calculate the median of the following values of data set obtained by measuring the heights of 22 plants in an experimental group to assess the effects of less water availability: (2)
- 8, 9, 10, 18, 10, 8, 9, 7, 8, 11, 23, 19, 17, 15, 7, 12, 14, 12, 11, 14, 15, 13.

Ans: _____

- iii). Calculate the median of the following dataset obtained by counting the number of flowers on 21 rose plants. (3)

Class (no. of flowers/plant)	1	2	3	4	5
Frequency (no. of plants)	3	5	6	4	3

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1**Calculations (working):**

Sr. No=n	Rate of photosynthesis = x	$x - \bar{x}$	$(x - \bar{x})^2$
1	12	-38.1	1451.61
2	13	-37.1	1376.41
3	30	-20.1	404.01
4	32	-18.1	327.61
5	49	-1.1	1.33
6	54	3.9	15.21
7	72	21.9	479.61
8	72	21.9	479.61
9	80	29.9	894.01
10	87	36.9	1361.61
	$\bar{x} = \frac{\Sigma x}{n} = 501/10 = 50.1$	$\Sigma(x - \bar{x}) = 0$	$\Sigma(x - \bar{x})^2 = 6791.02$

- i): **Mean:** $\bar{x}$ = Sum of all values divided by the count. $\frac{\Sigma x}{n}$
 $\bar{x} = (12+13+30+32+49+54+72+72+80+87) \div 10 = 501 \div 10 = 50.1$
- Median:** The data is already sorted. Since there are 10 values, the median is the average of the 5th and 6th values.
 $(49+54) \div 2 = 51.5$
- ii): **Mode:** Mode is the value that appears most frequently in dataset. mode is **72**, as it appears twice
- Range:** The difference between the maximum and minimum values. $87 - 12 = 75$
- iii): **Independent variable:** Intensity of light
Dependent variable: Rate of photosynthesis
- iv): **Standard deviation (σ or S)** $= S = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n-1}} = \sqrt{\frac{6791.02}{10-1}} = 27.47$
Variance $= \sigma^2 = 754.55$

Solution: Practical Based Assessment (PBA) Sample Paper- 2**Calculations (working):**

Sr. No=n	Height (cm)=x	$x - \bar{x}$	$(x - \bar{x})^2$
1	4	-5.71	32.6
2	7	-2.71	7.34
3	9	-0.71	0.50
4	10	0.29	0.08
5	10	0.29	0.08
6	13	3.29	10.8
7	15	5.29	27.9
	$\bar{x} = 68/7 = 9.71$	$\Sigma x - \bar{x} = 8.9$	$\Sigma(x - \bar{x})^2 = 79.3$

- i): **Mean:** $\bar{x}$ = Sum of all values divided by the count.
 $\bar{x} = (4+7+9+10+10+13+15) \div 7 = 68 \div 7 \approx 9.71$

- ii): **Median:** The middle value of the sorted data set. {4, 7, 9, **10**, 10, 13, 15} = **10**
Mode: The value that appears most frequently. mode is **10**, as it appears twice
Range: The difference between the maximum and minimum values. $15 - 4 = 11$
- iii): **Standard deviation (σ or S)** = $S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = S = \sqrt{\frac{79.3}{7-1}} = 3.63$
- iv): **Variance** = $\sigma^2 = 13.21$

Solution: Practical Based Assessment (PBA) Sample Paper- 3

Calculations (working):

Sr. No=n	Height (cm)=x	$x - \bar{x}$	$(x - \bar{x})^2$
1	150	-8	64
2	165	7	49
3	172	14	196
4	149	-9	81
5	155	-3	9
6	159	1	1
7	160	2	4
8	152	-6	36
9	155	-3	9
10	163	5	25
	$\bar{x} = 158$	$\Sigma (x - \bar{x})^2$	$\Sigma (x - \bar{x})^2 = 474$

- i): **Standard deviation (σ or S)** = $S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$
 $S = 7.26$
- ii): **Variance** = $\sigma^2 = 52.7$
- iii): **Standard error** = $\frac{S}{\sqrt{n}} = 2.38$
- iv): **Mean:** $\bar{x} = 158$ **Median:** = 157

Solution: Practical Based Assessment (PBA) Sample Paper- 4

- i): **Mean ($\bar{x}$):** The average height.
 $\bar{x} = \frac{\sum x}{n} = \frac{176+160+163+157+168+172+173+169+165}{9} = \frac{1503}{9} = 167 \text{ cm}$
 $\Sigma (x - \bar{x})^2 = (176-167)^2 + (160-167)^2 + (164-167)^2 + (157-167)^2 + (168-167)^2 + (172-167)^2 + (173-167)^2 + (169-167)^2 + (165-167)^2 = 316$
- ii): **Standard deviation (SD) (S/σ):**
 $S/\sigma = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n-1}} = 6.28 \text{ cm}$
- iii): **Variance (σ^2):** Measures the average squared deviation from the $\frac{\Sigma x}{n}$
 $\sigma^2 = \frac{\Sigma (x - \bar{x})^2}{n-1} = 39.5$
- iv): **Standard error** = $\frac{S}{\sqrt{n}} = 2.09$

Solution: Practical Based Assessment (PBA) Sample Paper- 5

- (i) a. Placing the leaf on a graph sheet and draw its outline.
 b. Counting the Complete and Partial squares.
 c. Applying the formula and calculating the surface of leaf.
- (ii) • Whole/Complete squares: Count the number of whole squares enclosed within the outline of the leaf. Take it to be **C**.
 • Partial squares: Count the number of squares that are more than half. Take it as **M**.
 Count the number of squares which are half of a whole square. Note it to be **H**.
 Count the number of squares that are less than half. Let it be **Q**.
- (iii) **Approximate area of the leaf = $C + (3/4)M + (1/2)H + (1/4)Q$ square cm.**

Solution: Practical Based Assessment (PBA) Sample Paper- 6

- (i) Arrangement of Data: 31, 33, 38, 46, 55, 66, 66, 68, 71, 72, 78, 82, 84, 87, 91
Value of "n": 15
Formula & Calculation: Median ($\bar{x}$) = $\left(\frac{n+1}{2}\right)^{th} = 15 + \frac{1}{2} = 8$
Find the 8th value in the sorted data: 68
FINAL ANSWER: The median of the data set is **68**.
- (ii) Arrangement of Data: The height of **22 plants** after arranging the values of dataset in ascending order are given below:
7,7,8,8,8,9,9,10,10,11,11,12,12,13,14,14,15,15,17,18,19,23
Value of "n": Total number of values in the above given dataset **n = 22 (Even number)**
Formula & Calculations: Median ($\bar{x}$) = $\frac{\left(\frac{n}{2}^{th} \text{ value}\right) + \left(\frac{n}{2} + 1\right)}{2} = \frac{\left(\frac{22}{2}\right) + \left(\frac{22}{2} + 1\right)}{2}$
 Median ($\bar{x}$) = $\frac{(11^{th} \text{ value}) + (12^{th} \text{ value})}{2} = \frac{(11) + (12)}{2}$
 Median ($\bar{x}$) = $\frac{11+12}{2} = \frac{23}{2} = 11.5$ (heights of plant)

(iii) Arrangement of Data

Class (no. of flowers/plant)	Frequency (no. of plants = n)	Cumulative frequency
1	3	3
2	5	8
3	6	14
4	4	18
5	3	21

Value of "n": Number of plants (**n**) = 21

Formula: Median ($\bar{x}$) = $\left(\frac{n+1}{2}^{th}\right)$ cumulative frequency

Calculation: Median ($\bar{x}$) = $\left(\frac{21+1}{2}\right) = \frac{22}{2} = 11$

ANSWER: Since cumulative frequency 11 is included in 14 which represent the class value 3, therefore, for cumulative frequency 11, the class value will be 3 which is the median.

TEST YOUR SKILLS**Mean, Mode, Median, and Range**

- 1) 82, 23, 59, 94, 70, 26, 32, 83, 87, 94, 32
23, 26, 32, 32, 59, 70, 82, 83, 87, 94, 94

Mean 62 Median 70 Mode 32 94 Range 71

- 6) 67, 70, 49, 95, 40, 97, 62, 54, 42
40, 42, 49, 54, 62, 67, 70, 95, 97

Mean 64 Median 62 Mode None Range 57

- 2) 83, 93, 77, 33, 62, 28, 23
23, 28, 33, 62, 77, 83, 93

Mean 57 Median 62 Mode None Range 70

- 7) 86, 13, 60, 55, 61, 97, 30, 98, 79, 52, 18
13, 18, 30, 52, 55, 60, 61, 79, 86, 97, 98

Mean 59 Median 60 Mode None Range 85

- 3) 31, 92, 25, 69, 80, 31, 29
25, 29, 31, 31, 69, 80, 92

Mean 51 Median 31 Mode 31 Range 67

- 8) 24, 22, 32, 59, 99, 59, 76, 83, 21, 95, 57
21, 22, 24, 32, 57, 59, 59, 76, 83, 95, 99

Mean 57 Median 59 Mode 59 Range 78

- 4) 21, 62, 66, 66, 79, 28, 63, 48, 59, 94, 19
19, 21, 28, 48, 59, 62, 63, 66, 66, 79, 94

Mean 55 Median 62 Mode 66 Range 75

- 9) 63, 25, 43, 28, 72, 61, 45, 46, 13
13, 25, 28, 43, 45, 46, 61, 63, 72

Mean 44 Median 45 Mode None Range 59

- 5) 83, 23, 24, 71, 52, 62, 63
23, 24, 52, 62, 63, 71, 83

Mean 54 Median 62 Mode None Range 60

- 10) 53, 44, 10, 45, 59, 97, 77
10, 44, 45, 53, 59, 77, 97

Mean 55 Median 53 Mode None Range 87

SECTION-A

MODEL SAMPLE PAPER-1

(18 Marks)

Q.1 Given in the diagram is a leaf. A student is sketching the leaf on graph paper:

i). Calculate its complete squares: (1)

Ans: _____

ii). Calculate its partial squares: (1)

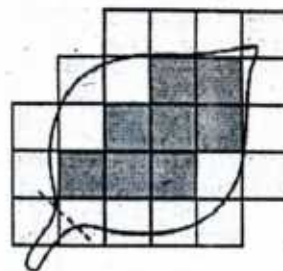
Ans: _____

iii). Calculate the leaf surface area: (2)

Ans: _____

iv). What does leaf surface area depict/indicate? (2)

Ans: _____

1 square = 1 cm²1 square = 1 cm²

Q.2 Amir set up an experiment to measure the rate of reaction between catalase and excess Hydrogen peroxide. He measured the amount of Oxygen given off in the reaction.

i). Calculate the rate between 0-20 seconds (2)

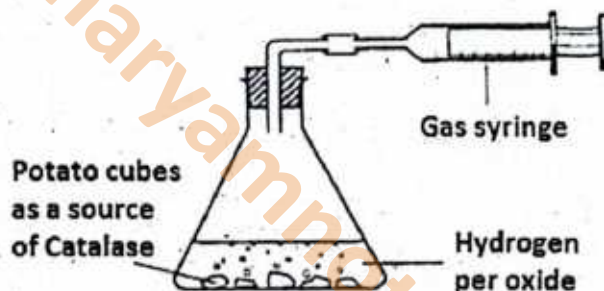
Ans: _____

ii). Calculate the rate between 20-50 seconds. (2)

Ans: _____

iii). Why does the rate change? (2)

Ans: _____

Potato cubes
as a source
of Catalase

Gas syringe

Hydrogen
per oxide

Results	
Time (seconds)	Volume of gas (cm ³)
0	0
10	20
20	40
30	58
40	72
50	80
60	

Q.3 A study was conducted to check the infection rate in the blood of 7 members of the same family having same blood groups. The haemo-pathological report after treating with a newly introduced antibiotics provides us the infection rate data as (22, 23, 25, 28, 30, 33, 35) reducing from the value of 34 infection rate.

i): Find out the mean and median of the family infection rate: (2)

Ans: _____

ii): Calculate the Standard deviation of the family infection rate: (1)

Ans: _____

iii): Calculate the standard error of the family infection rate: (1)

Ans: _____

iv): Which individual is showing the anomalous reading among the family for infection rate; moreover to which individual antibiotic resistance is least, give reason: (2)

Ans: _____

Solution:

Model Paper-1

Section-A

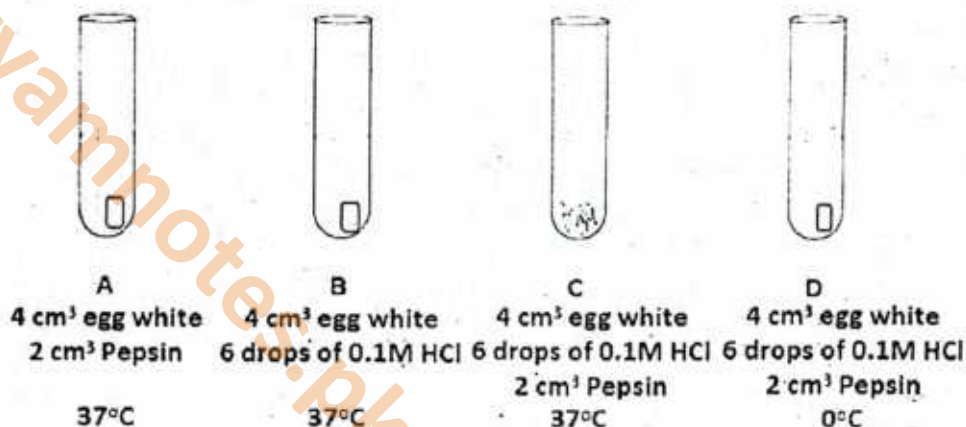
- Q.1**
- i). No. of complete squares under the leaf trace $C = 08 = 08 \text{ cm}^2$
 - ii). No. of partially covered squares $P = 07 = 7 \times 0.5 = 3.5 \text{ cm}^2$
 - iii). Total leaf area $= 08 + 3.5 = 11.5 \text{ cm}^2$
 - iv). Leaf surface area is an important indicator of a plant's photosynthetic capacity, as it is directly related to the amount of light that a plant can capture. Measuring leaf surface area can help ecologists to understand how different plant species differ in their photosynthetic capacity.
- Q.2**
- i): **Rate = Change in amount of product/Time** $= (40-0) / 20 = 2 \text{ cm}^3/\text{sec}$
 - ii): **Rate = Change in amount of product/Time** $= (80-40) / 30 = 1.33 \text{ cm}^3/\text{s}$
 - iii): Over the course of a reaction, the reactant particles will get used up, so the rate of reaction will fall.
- Q.3**
- i): Mean = 28 Median = 28
 - ii): Standard deviation = $S = 4.60$
 - iii): Standard Error = $SE = 1.7$
 - iv): The last individual with the value of 35 is giving anomalous reading. Moreover the Individual with value 22 shows least resistance to antibiotic and reducing its infection rate.

SECTION-A

MODEL SAMPLE PAPER-2

(18 Marks)

- Q.1 Temperature and pH impact enzyme activity by affecting the enzyme's structure and the rate of collisions. The given experiment represents the effect of temperature and pH on Pepsin Enzyme catalysis.



- i): Which would be the dependent variables in above experiment: (1)

Ans:

- ii): Which would be the independent variables in above experiment: (1)

Ans:

- iii): What would be the changes you expect if Enzyme is Trypsin: (2)

Ans:

- iv): Draw a comprehensive line graph for optimum ranges of pH and temperature of pepsin enzyme: (2)

Ans:

- Q.2** The Kirby-Bauer test is based on the principle of diffusion of antimicrobial agents from impregnated disks into an agar medium that has been inoculated with the microorganism of interest. The following zone of inhibition were obtained against *S.aureus* and *E.coli* by using 4 types of antibiotics:

Chemotherapeutic agent	<i>Staphylococcus aureus</i> Zone of inhibition	<i>Escherichia coli</i> Zone of inhibition
Ampicillin	20 mm	20 mm
Erythromycin	25 mm	15 mm
Streptomycin	16 mm	10 mm
Bacitracin	7 mm	5 mm

- i): According to the table which antibiotics are most effective against *S.aureus* and *E.coli*? (2)

Ans:

- ii): Are *S.aureus* and *E.coli* Susceptible/sensitive (s), Intermediate (I) or Resistant (R) to Ampicillin? (2)

Ans:

- iii): Which one antibiotic is more likely to be effective for both *S.aureus* and *E.coli*? (2)

Ans:

- Q.3** Heights (in cm) of 9 male students, all aged 18 years, were measured. The heights of 9 male students (in cm) are: 176, 160, 163, 157, 168, 172, 173, 169, 165. Show your calculations and readings to find:

- i): Find out the Median value in the above heights of students. (2)

Ans:

- ii): Calculate standard deviation for the above dataset. (2)

Ans:

- iii): Derive variance for the given data of students. (2)

Ans:

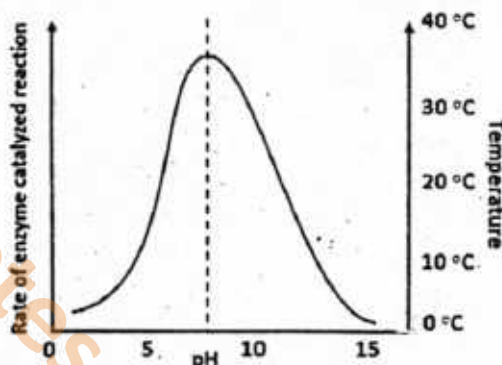
Solution:**Model Paper-2****Section-A**

Q.1 i): Dependent variables: Rate of enzyme action (catalysis)

ii): Independent variables: Temperature and pH

iii): If enzyme is Trypsin then the pH should be basic (8-9) because it would not work in acidic medium.

iv):



Q.2 i): Erythromycin for S.aureus and Ampicillin for E.coli?

ii):

Chemotherapeutic agent	Staphylococcus aureus	Escherichia coli
Ampicillin	S	S
Erythromycin	S	S
Streptomycin	I	I
Bacitracin	R	R

iii): Ampicillin

Q.3 i): Mean ($\bar{x}$): The average height.

$$\bar{X} = \frac{\sum x}{n} = \frac{176+160+163+157+168+172+173+169+165}{9} = \frac{1503}{9} = 167 \text{ cm}$$

$$\sum (X - \bar{x})^2 = (176-167)^2 + (160-167)^2 + (164-167)^2 + (157-167)^2 + (168-167)^2 + (172-167)^2 + (173-167)^2 + (169-167)^2 + (165-167)^2 = 316$$

ii): Standard deviation (SD) (S/σ):

$$S/\sigma = \sqrt{\frac{\sum (X - \bar{x})^2}{n-1}} = 6.28 \text{ cm}$$

iii): Variance (σ^2): Measures the average squared deviation from the $\frac{\sum x}{n}$

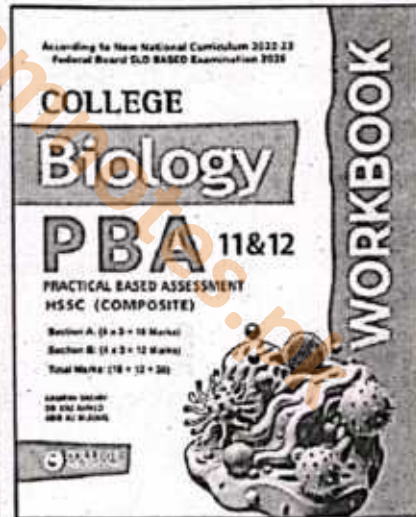
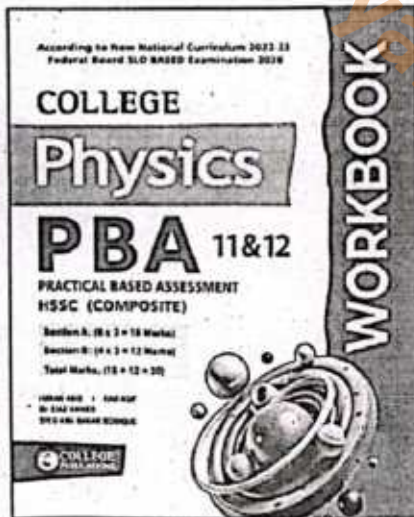
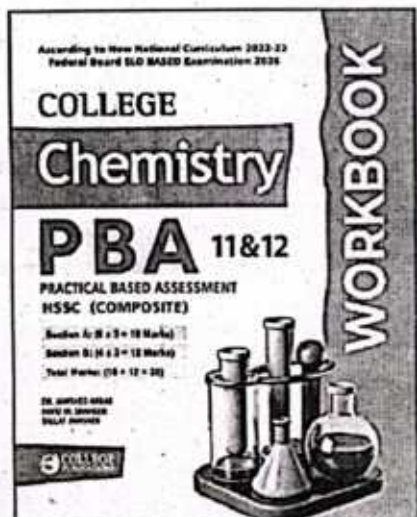
$$\sigma^2 = \frac{\sum (x - \bar{x})^2}{n-1} = 39.5$$

SECTION B

40% of Practical Marks

12 Marks

MINOR PRACTICALS





SET UP A LIGHT MICROSCOPE TO VIEW AND OBSERVE SPECIMENS

Compound Microscope

Microscope is an instrument used to observe small objects. The microscope with two lenses is called compound microscope. The source of illumination for compound microscope is simple light. There are following part of compound microscope.

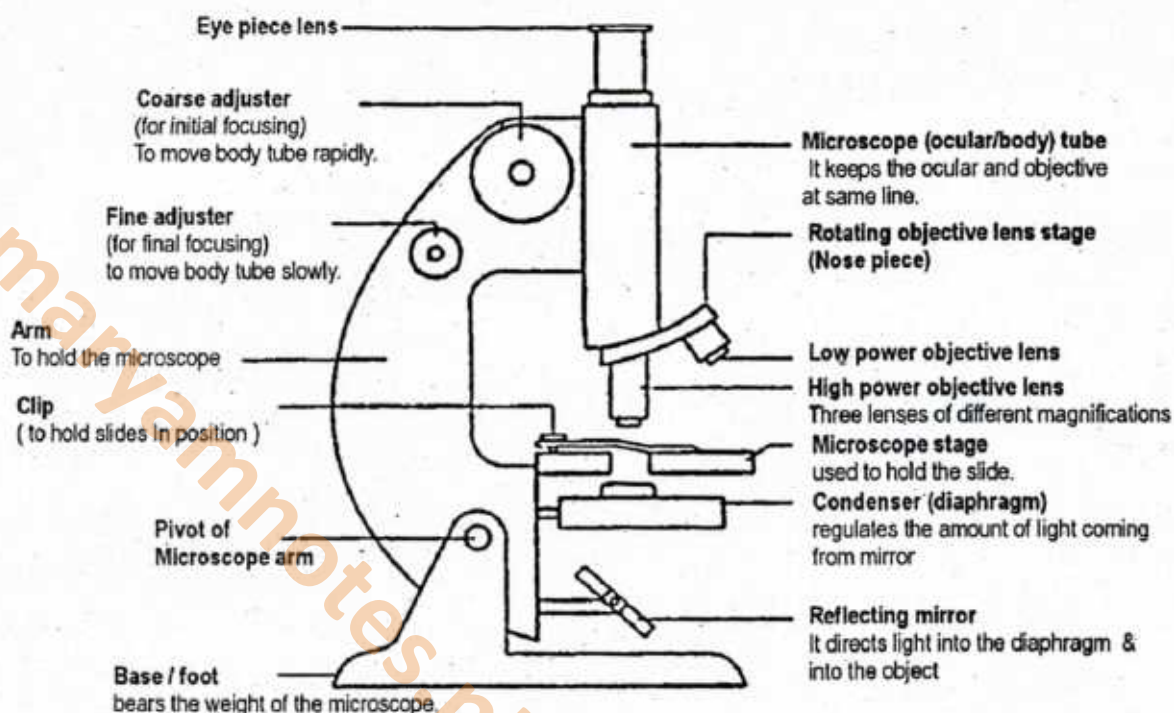
1. **Eye piece or ocular:**
Eye piece is short tube. It contains lens called ocular. This lens can be replaced by high power lens.
2. **Body tube:**
At one end of this tube is present ocular. At other end is present nose piece. Therefore, it keeps the ocular and objective at same line.
3. **Nose piece:**
It is a short tube present at the distal end of body tube. It contains three lenses of different magnifications. It can rotate with body tube. Therefore, it is used to bring the required lens in focus.
4. **Arm:**
It is use to hold the microscope from its side. It is attached with body tube at upper end. At lower end it is attached with the base. The arm has two adjustments:
 - (a) **Coarse adjustment:** It is used to move body tube rapidly.
 - (b) **Fine adjustment:** It is used to move body tube slowly. Therefore, it gives fine adjustment.
5. **Stage:**
It is flat surface present below the nose piece. It gives support to slide. It has two clips. These clips are used to hold the slide.
6. **Diaphragm:**
It is a circular body present below the stage. It regulates the amount of light coming from mirror
7. **Mirror:**
Mirror is attached at the base of microscope. Its one surface is convex and other surface is concave. It directs light into the diaphragm. Diaphragm then directs light into the object.
8. **Base:**
It is present at the base of microscope. It bears the weight of the microscope.

Magnification of Microscope

The number of times which a microscope increases size of an object as compared to its original size is called magnification of microscope or power of microscope. It is obtained by multiplying the power of ocular with power of objective. For example, if power of ocular is 10X and power of objective is 100X, then magnification will be $10 \times 100 = 1000$. It means that this microscope can increase the size of object by 1000 times.

Procedure of Focusing Light

1. Microscope is placed on a table
2. The specimen (slide) is placed on the stage. It is held in its position by clips.
3. At start microscope is kept at low power.
4. Now light is focused on object by revolving the mirror. At one point there is maximum light available.
5. Coarse and fine adjustments are used to increase the visibility of specimen.



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. **Name two lenses of microscope?**

Ans: Ocular and objective

2. **What is difference between compound and electron microscopes?**

Ans: The source of illumination for compound microscope is simple light. But the source of illumination for electron microscope is moving electron.

3. **Why is compound microscope called so?**

Ans: Multiple lenses are used in compound microscope. Therefore it is called compound microscope.

4. **What is meant by magnification of microscope?**

Ans: The number of times which a microscope increases the size of an object as compared to its original size is called magnification of microscope.

5. **What is the power of resolution?**

Ans: Minimum distance between 2 points in which our eye can differentiate is called resolution of eye.

6. **What is a microscope?**

Ans: A microscope is an instrument, used to magnify small objects that cannot be seen by the naked eyes.

7. **What is an electron microscope?**

Ans: An electron microscope is a device used to study the ultra structure of muscles and other cell organelles. In electron microscope, a beam of high speed electrons is used for magnification.

8. **How many times does an electron microscope magnify?**

Ans: An electron microscope magnifies the object about 2,50,000 times than naked eye.

9. **How many times does a compound microscope magnify?**

Ans: Magnifying power of a compound microscope is equal to the magnifying power of the objective lens into the magnifying power of the eyepiece lens.

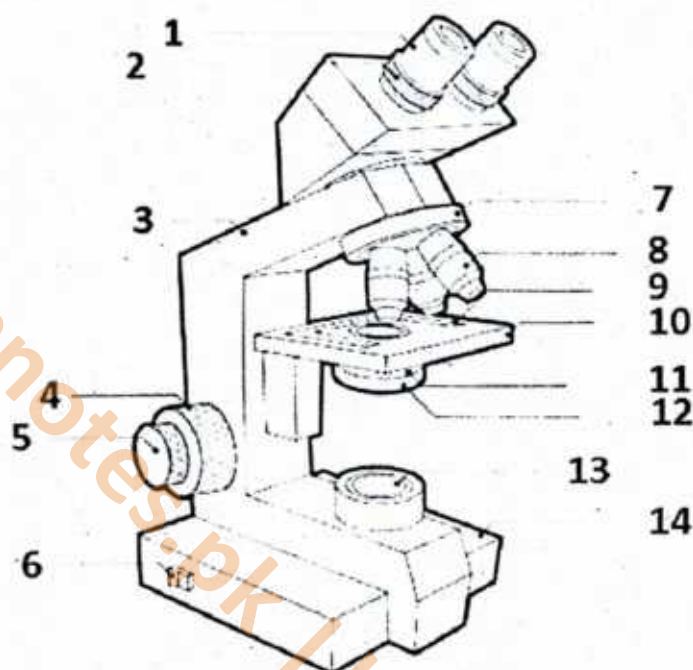
Accordingly the magnifying power can vary from 100 times (10x 10) to 600. Times (15x 40).

10. **Name various other types of microscopes?**

Ans: Phase contrast microscope, Fluorescent microscope, JV microscope, Polarizing microscope, Interference microscope etc.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

- (1) Given below is the diagram of a compound microscope. Observe the figure carefully and answer the following questions:



- (i) Identify and write the functions of the labelled parts 12 and 13 in above diagram. (2)

Ans:

- (ii) Differentiate between the labelled parts 1 and 8 in above diagram. (2)

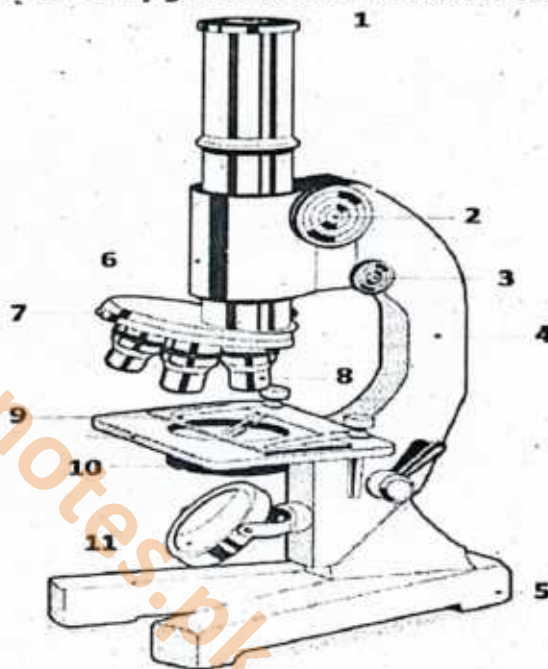
Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) **12-Condenser/ Diaphragm:** It regulates the amount of light coming from the light source.
13-Light source/ Mirror: It directs the light into diaphragm and into the object.
- (ii) **1-Ocular lens:** The ocular lens, or eyepiece, is the lens closest to the observer's eye and provides a second stage of magnification.
8-Objective lens: The objective lens is located near the specimen, gathers light from it, and creates an initial, magnified "real image".

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

- (1) Compound microscope is used to magnify the objects that cannot be seen through naked eyes. Observe the figure carefully given below and answer the questions:



- (a) Write the numbers of the structures that are involved in calculating the magnification of an object/specimen. How magnification power of a microscope is measured? (2)

Ans: _____

- (b) Define magnification power. What is the magnification powers of compound microscope and electron microscope. (2)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper-2

- (a) **Number 1 (Ocular lens) & 8 (Objective lens)** are involved in calculating the magnification of an object/specimen. The total magnification of a compound microscope is the product of the powers of the ocular and objective lenses. e.g; if you are using the 40 X objective lens with a 10 X ocular lens, the total magnification would be $40 \times 10 \times = 400 \times$.
- (b) **Magnifying power** is the measure of how much larger an object appear compared to its actual size (Naked eye) when viewed under a microscope. A **compound microscope** typically has a magnification power of up to 2,000 X, while an **electron microscope** can magnify an image by 1,000,000X to 5,000,000X .

EXPERIMENT 10

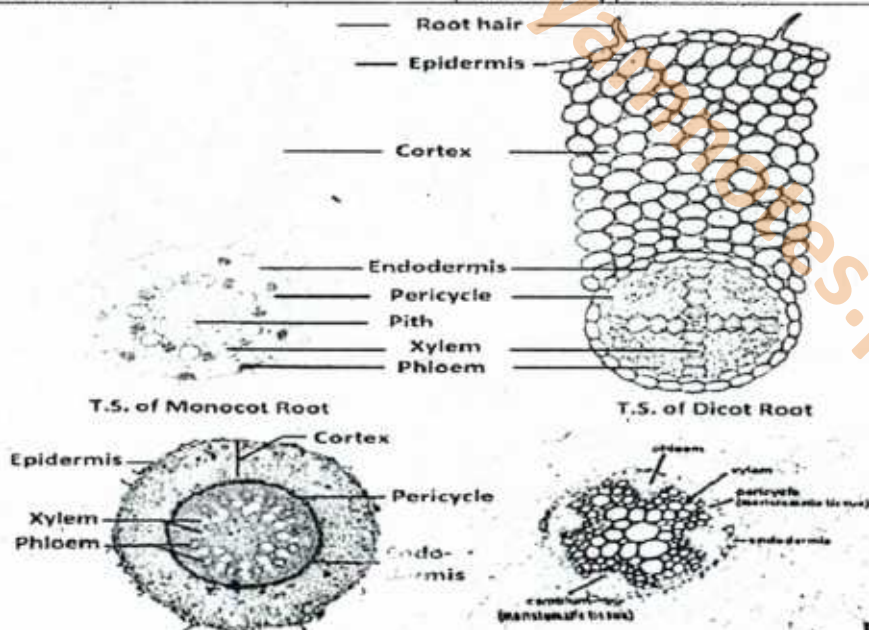
TO FIND AND DRAW PARTICULAR TISSUES IN PLANT SPECIMENS PRESERVED IN PERMANENT SLIDES:

The thin transverse sections of a monocot root/stem (*Zea mays*) and dicot root/stem (*Brassica campestris*) stained with safranin reveals the following internal structure under a microscope.

(A) T.S OF MONOCOT ROOT

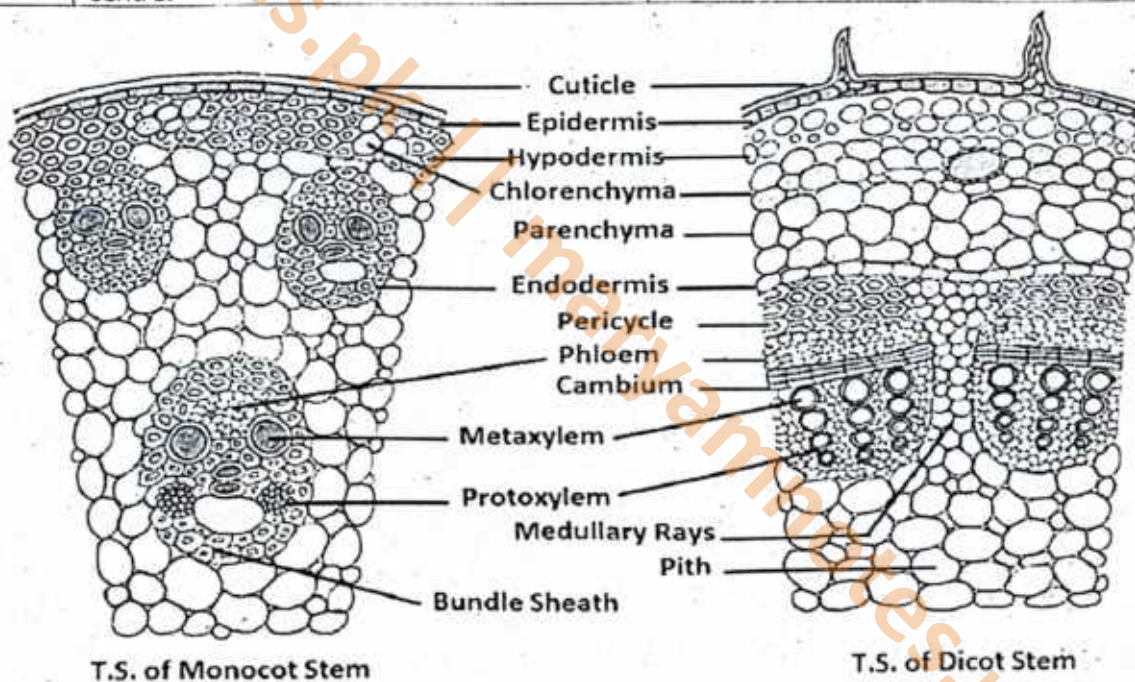
(B) T.S OF DICOT ROOT

FEATURES	T.S OF MONOCOT ROOT	T.S OF DICOT ROOT
1. Epidermis:	Single outer-most layer with a number of unicellular root-hairs.	Single outer-most layer with a number of unicellular root-hairs.
2. Cortex:	Many-layered zone of round or oval cells and cortex is very wide.	Many layers of thin-walled rounded cells & cortex is comparatively narrow.
3. Endodermis:	Innermost layer of the cortex and forms a definite ring around the stele. Cells of the endodermis are barrel-shaped.	Innermost layer of the cortex and forms a definite ring around the stele. Cells of endodermis are barrel-shaped.
4. Pericycle:	Ring-like layer lying internal to the endodermis & gives rise to lateral roots	Single ring-like layer lying internal to endodermis & forms cork cambium
5. Pith:	Mass of parenchymatous cells in and around the centre	A small area in the centre of the root in some monocots or may be absent.
6. Vascular Bundles:	Arranged in a ring. The arrangement is radial. Vascular Bundles are numerous.	Vascular Bundles are star shaped and present in the centre. The arrangement is radial. Vascular Bundles varies from 2 to 8.
Reasons for Identification	Vascular bundles are arranged in a ring. Pith is large and in the center. Cambium absent.	Vascular Bundles are star shaped. Pith is absent. Cambium appears later on.



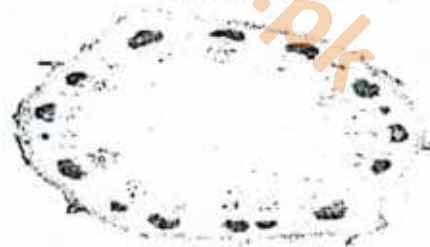
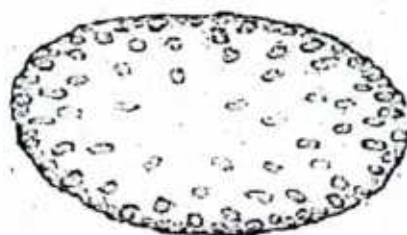
(C) T.S OF MONOCOT STEM**(D) T.S OF DICOT STEM**

FEATURES	T.S OF MONOCOT STEM	T.S OF DICOT STEM
1. Epidermis:	A single outermost layer Thick cuticle on the outer surface. A few stomata in epidermis.	A single outermost layer Thick cuticle on the outer surface. A few stomata in epidermis.
2. Hypodermis:	Hypodermis is chlorenchymatous.	Hypodermis is sclerenchymatous.
3. Medullary Rays:	Medullary rays are absent.	Medullary rays are present.
4. Pericycle:	Pericycle is absent in the monocot stem.	Pericycle is present in the dicot stem
5. Pith:	Pith is absent in monocot stem.	Pith is present in the dicot stem.
6. Vascular Bundles:	Vascular bundles are scattered. monocot stem and dicot stem is that Vascular bundles are numerous. Outer vascular bundles are smaller than the inner vascular bundles. Xylem elements are circular.	Vascular bundles are arranged in the form of rings. Vascular bundles are Few (4 to 8). All vascular bundles are equal in size in dicot stems Xylem elements are polygonal.
Reasons for Identification	1. Vascular bundles are scattered, collateral, closed and not arranged in a ring. 2. Pith is not marked out (absent). 3. Larger vascular bundles are towards the centre.	1. Vascular bundles are arranged in a ring, collateral, open and of uniform size. 2. Pith forms the centre cylinder. 3. All vascular bundles are equal in size



T.S. of Monocot Stem

T.S. of Dicot Stem



(E) TRANSVERSE SECTION OF BIFACIAL/DORSI-VENTRAL LEAF

The thin transverse sections of a dicot Leaf (*Brassica campestris*) stained with safranin reveals the following internal structure under a microscope.

Bifacial leaf

A bifacial leaf, also called a dorsiventral leaf, is a leaf with distinct upper and lower surfaces that are structurally and functionally different. This is a common leaf type in dicots and is characterized by a differentiation of inner tissue (mesophyll) into a palisade layer on the top & a spongy layer on bottom

Upper Epidermis:

This is a single layer of cells with a thick cuticle. It does not contain chloroplast, stomata are very less or usually absent.

Lower Epidermis:

This is also a single layer but with a thin cuticle. It has numerous stomata, the two guard cells, which contain some chloroplasts, none are present in the epidermal cells. Each stoma has a large cavity called air cavity may be seen.

Mesophyll:

The ground tissue lying between the upper epidermis and the lower one is known as the mesophyll. It is differentiated into:

a) Palisade parenchyma:

It consists of usually one to two or three layers of elongated, more or less cylindrical cells, closely packed with their long axis at right angles to the epidermis. The cells contain numerous chloroplasts.

b) Spongy parenchyma:

It consists of oval, rounded, or more commonly irregular cells, loosely arranged towards the lower epidermis, enclosing numerous, large, intercellular spaces and air-cavities. They however, fit closely around the vein or the vascular bundle. The cells contain a few chloroplasts.

Vascular Bundles:

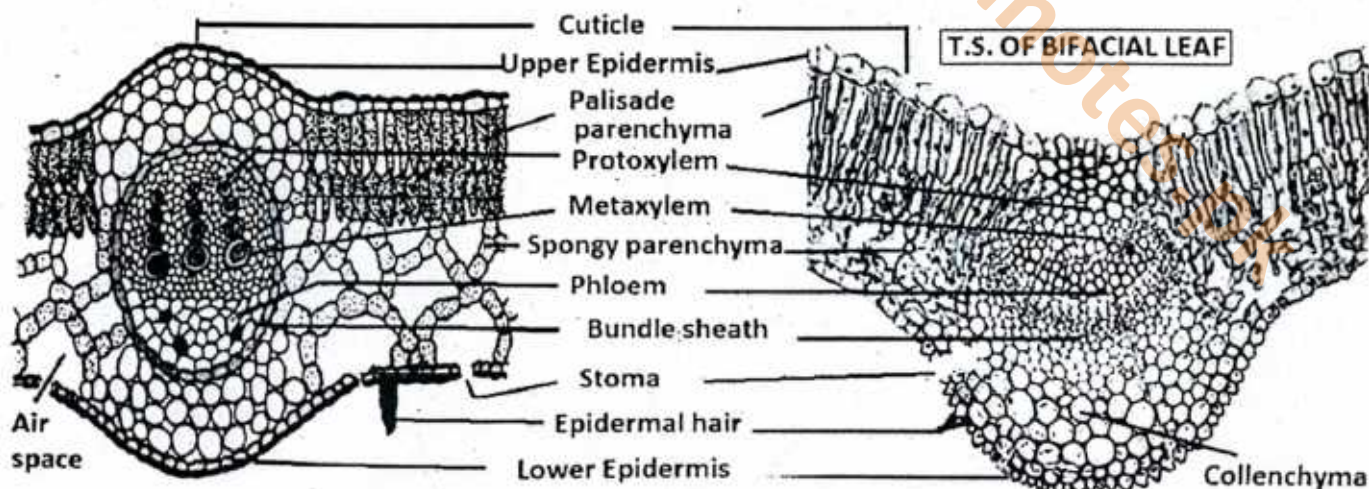
Each vascular bundle (vein) consists of:

Xylem, towards the upper epidermis, consists of various kinds of vessels (particularly annular and spiral), tracheids, wood fibres and wood parenchyma.

Phloem, towards the Lower epidermis, consists of some narrow sieve-tubes, companion cells & phloem parenchyma

Reasons for Identification:

1. Mesophyll consists of palisade and spongy parenchyma.
2. Upper and lower epidermis present.
3. Stomata are on the lower epidermis only.



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1: What are monocots; give examples?

Ans: Monocots are flowering plants with one embryonic leaf (cotyledon) in their seeds. They are characterized by having parallel-veined leaves, flower parts in multiples of three, and fibrous root systems. Examples of monocots include grasses, wheat, rice, orchids, lilies, and palms.

Q.2: What are dicots; give examples?

Ans: Dicots are a group of flowering plants that have two embryonic leaves, called cotyledons, in their seeds. They are characterized by having net-like veins in their leaves and flowers with four or five petals. Examples include sunflowers, roses, oak trees, & tomatoes.

Q.3: Differentiate between monocots and dicots; give examples?

Ans:



Seeds have two cotyledons



Flowers have four or five floral parts (or multiples thereof)



Leaves are oval or palmate, with net-like veins



Vascular bundles arranged in a ring around stem



Tap roots

MONOCOTS

DICOTS



Seeds have one cotyledon



Flowers have three floral parts (or multiples thereof)



Leaves are narrow, with parallel veins



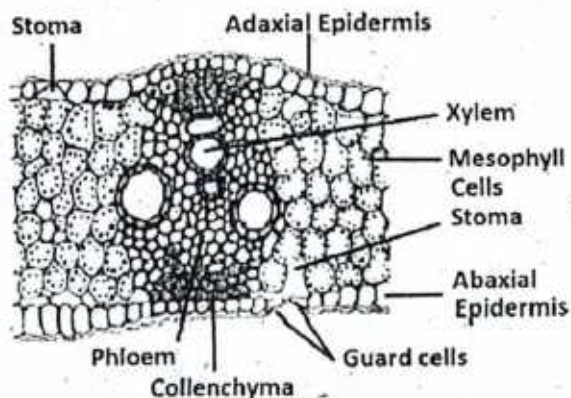
Vascular bundles small, and spread throughout stem



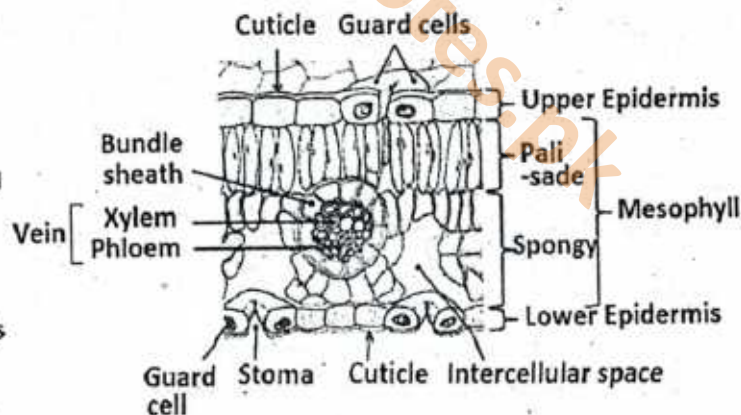
Fibrous roots

Q.4: Draw the comparison diagram of Unifacial/Iso-bilateral and Bifacial/Dorsi-ventral leaves:

Ans:



T.S. of Unifacial and Monocot Leaf



T.S. of Bifacial and Dicot Leaf

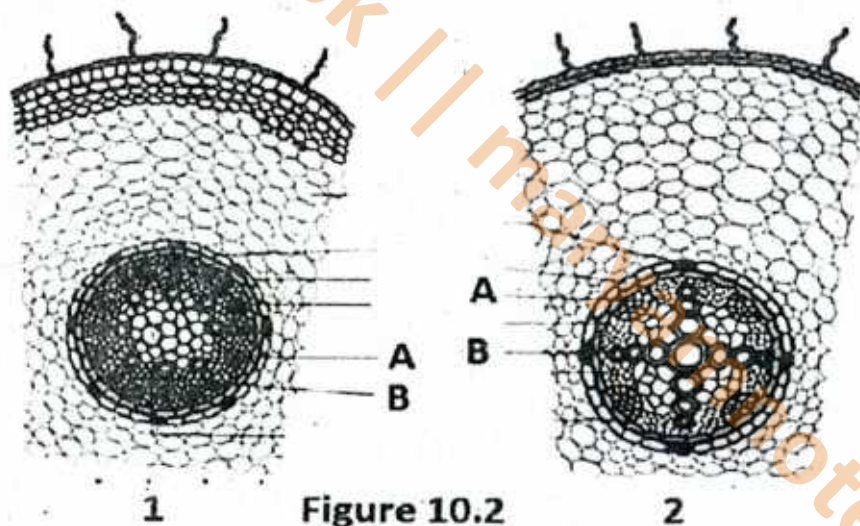
Q.5: Differentiate between Unifacial/Iso-bilateral and Bifacial/Dorsi-ventral leaves:

Ans: A unifacial leaf is a type of leaf that has only one face, lacking the distinct upper (adaxial) and lower (abaxial) surfaces seen in a typical bifacial leaf. For example like iris, leeks, and some onions.

FEATURES	UNIFACIAL/ISOBILATERAL LEAF	BIFACIAL/DORSIVENTRAL LEAF
Internal Structure:	Internal structure is the same on both sides, leading to an "equifacial" or "isofacial" symmetry.	Has a clear distinction between the top (adaxial) and bottom (abaxial) sides, with palisade parenchyma on top and spongy parenchyma below.
Stomata Location	Stomata are typically present on both the upper and lower epidermis.	Stomata are primarily located on the lower epidermis (bottom side).
Appearance	Exhibits a more uniform appearance on both sides. They are less common and are usually found in monocots.	Shows a distinct top and bottom face, appearing "two-faced". They are more common and are found in dicots.
Growth	The leaf lamina expands through extensive thickening without the establishment of an adaxial domain or a plate meristem.	The leaf lamina expands by the activity of a plate meristem, creating distinct adaxial and abaxial domains.
Examples	like some grasses or sedges.	such as a sunflower or a rose.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

(1) Given below is Transverse sections of plant organs showing vascular bundles:



(i) Identify the figure 10.2 (1 & 2); Also label its parts.

(2)

Ans:

(ii) Write 4 differences in short between Figure 1 and 2.

(2)

Ans:

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

(1) Identify the given diagram:

(a) Label the parts B & D; also give their role: (2)

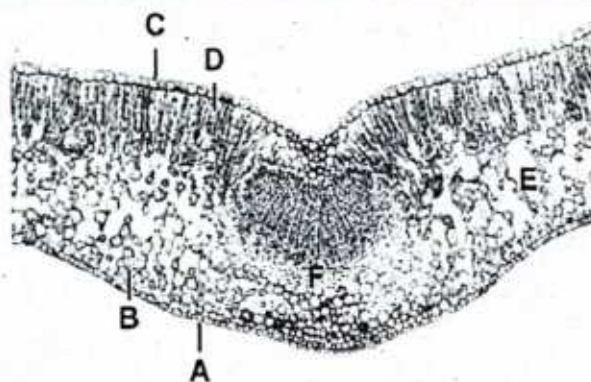
Ans: _____

(b) Label the part F; also give its role: (1)

Ans: _____

(c) Define bifacial leaf; give example: (1)

Ans: _____

**PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3**

(1) Given below is Transverse sections of plant organs:

(i) Identify the figure 10.1. (2)

Ans: _____

(ii) Write 4 differences in short between Figure A and B. (2)

Ans: _____

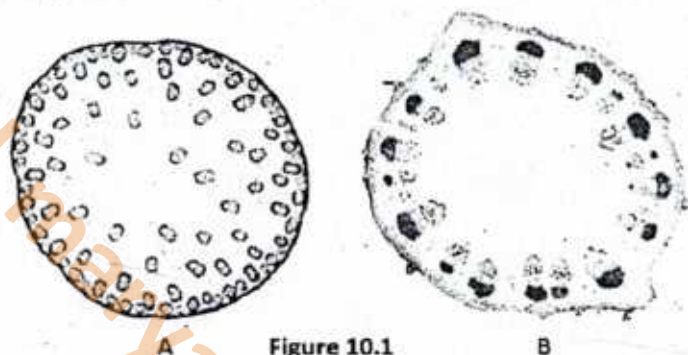


Figure 10.1

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i) 1: T.S. of monocot root.

2: T.S. of Dicot Root.

A: Phloem

B: Xylem

(ii) See Reasons for identification in text A and B.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(a) B: Spongy parenchyma/mesophyll tissues: D: Palisade parenchyma/mesophyll tissues:
Both these mesophyll tissues are involved in photosynthesis.

(b) F: Phloem: Involved in the conduction of food to various parts of plant.

(c) A leaf with distinct upper and lower surfaces that are structurally and functionally different. Any dicot Leaf like *Brassica campestris*, Gram, peanut, pea etc.

Solution: Practical Based Assessment (PBA) Sample Paper- 3

(i) A: T.S. of monocot stem.

B: T.S. of Dicot stem.

(ii) See Reasons for identification in text C and D.

EXPERIMENT

11

TO FIND AND DRAW PARTICULAR TISSUES IN ANIMAL SPECIMENS PRESERVED IN PERMANENT SLIDES:

Materials:

Compound microscope, prepared slides of Particular animal tissues, Note book and pencil colours.

Procedure:

1. Observe the prepared slides under different resolutions of compound microscope.
2. Draw the diagrams of structures.

(A) T.S OF SEMINIFEROUS TUBULES IN HUMAN TESTES

The prepared/stained permanent slide of thin transverse section (T.S) of a Seminiferous tubule of Human testes reveals the following structures under a microscope.

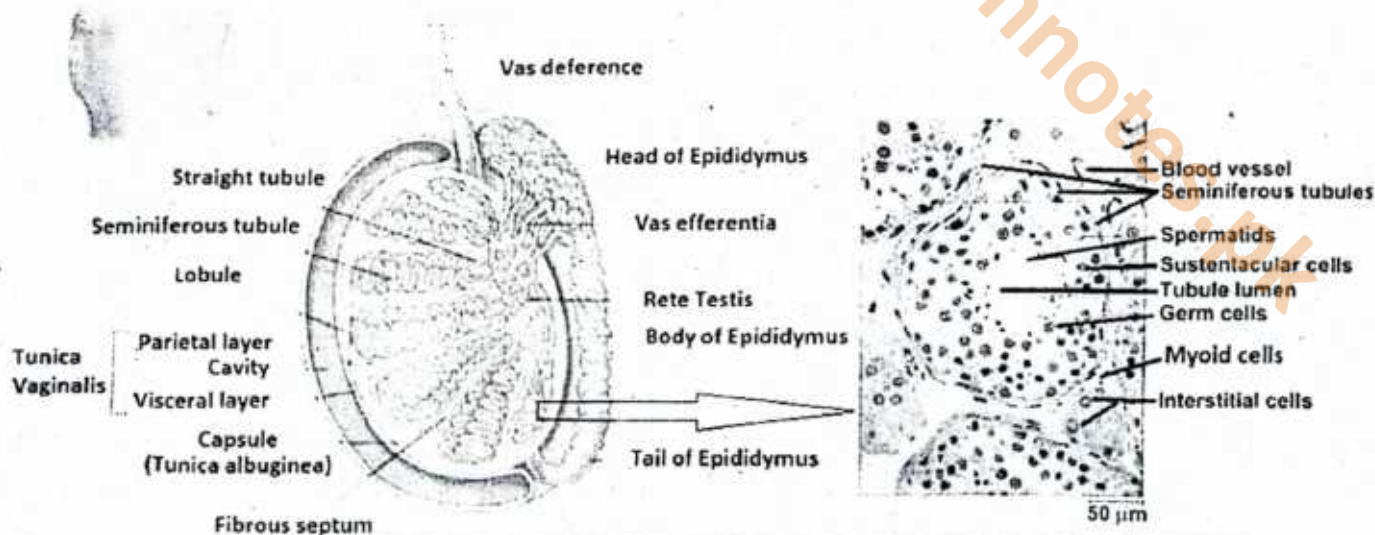
TESTES: In humans the testes occur as a pair of oval-shaped organs that produce sperms. Each Human testis weighs about 25 grams and is 4–5 cm long and 2–3 cm in diameter.

SCROTUM: In humans, Paired testes are present outside the body contained within a thin skin pouch called scrotal sac or Scrotum, which is located directly behind the penis and in front of the anus. The reason is that the spermatogenesis (process of sperm production), is most efficient around 35°C , two degrees cooler than body temperature.

LAYERS OF TESTES: In humans the testis is composed of 3 Layers:

- (a) **Tunica Vaginalis**, is the extension of peritoneal cavity with mesothelial cells;
- (b) **Tunica Albuginea** is a tough fibrous septa that extends into testis and separates it into in to 250 to 300 wedge-shaped sections, or lobes/Lobules.
- (c) **Tunica Vascularia** is the inner most Tissue layer.

MEDIASTINUM: The partitions between the lobes and the seminiferous tubules both converge in one area near the anal side of each testis to form what is called the mediastinum testis.



CROSS SECTION OF TESTES

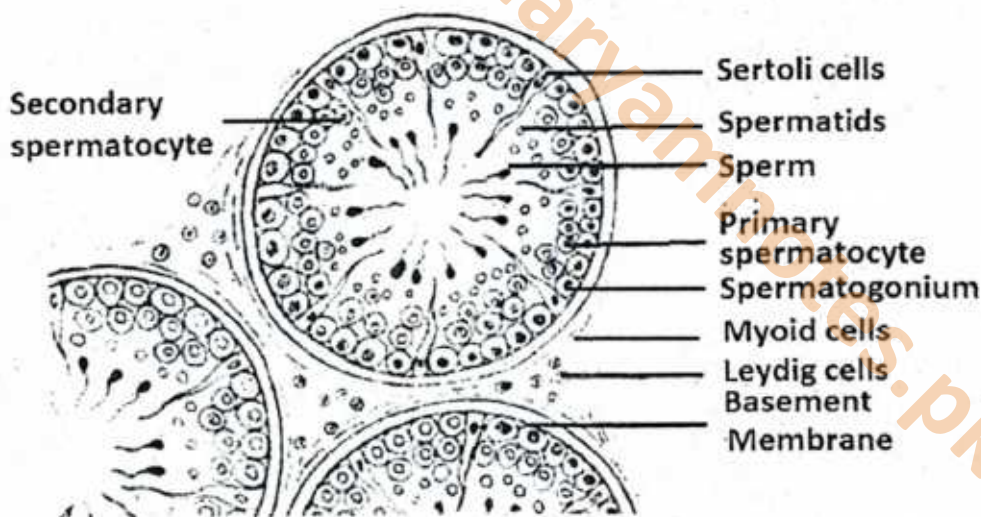
CROSS SECTION OF SEMINIFEROUS TUBULE

SEMINIFEROUS TUBULES:

Each lobule contains 1 to 4 tightly coiled seminiferous tubules, which produce sperms. Seminiferous tubules are 150 - 250 microns in diameter, the average total length in each testes is 540 m (range 299 - 981 m). It is lined by multilayered epithelium with most mature cells towards lumina. These tubules have basal lamina, outer **myoid cells** (positive for desmin, muscle specific actin, vimentin) and collagen. Seminiferous tubules contain **Sertoli cells**, spermatogonia (types A and B), primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa.

Each seminiferous tubule on its cross section reveals following cells:

	Sertoli cell (Sustentacular cells)	Leydig cell (Interstitial cells)
1.	These are present in between germinal epithelial cells of seminiferous tubules.	These are present in between the seminiferous tubules.
2.	These cells are found singly and are elongated, Columnar, on basement membrane. Have irregular, highly folded nuclei	These are found singly (20 microns) or in smaller groups & are round in shape. Have round nuclei
3.	a. they provide nourishment to the developing spermatozoa-sperms. b. they also secrete androgen binding proteins (ABP) that concentrates testosterone in seminiferous tubules. c. It also secretes a protein hormone Inhibin that suppresses FSH synthesis.	They secrete androgens (e.g; Testosterone) in response to ICSH. Leydig cells can synthesize cholesterol de novo within them, as well as acquire cholesterol through LDL and HDL receptors (scavenger receptors) in the blood.
4.	FSH stimulates spermatogenesis by stimulating the Sertoli cells to complete the development of sperms from Spermatids.	LH stimulates Leydig cells to release testosterone. Testosterone causes the growth and development of germinal epithelium to form sperms.



T.S. through Testes of Seminiferous Tubules

(B) T.S OF GRAAFIAN FOLLICLE IN HUMAN OVARY

The prepared/stained permanent slide of thin transverse section (T.S) of a Graafian follicle in human ovary reveals the following structures under a microscope.

Graafian (Mature/ Vesicular/Tertiary/Antral) Follicle:

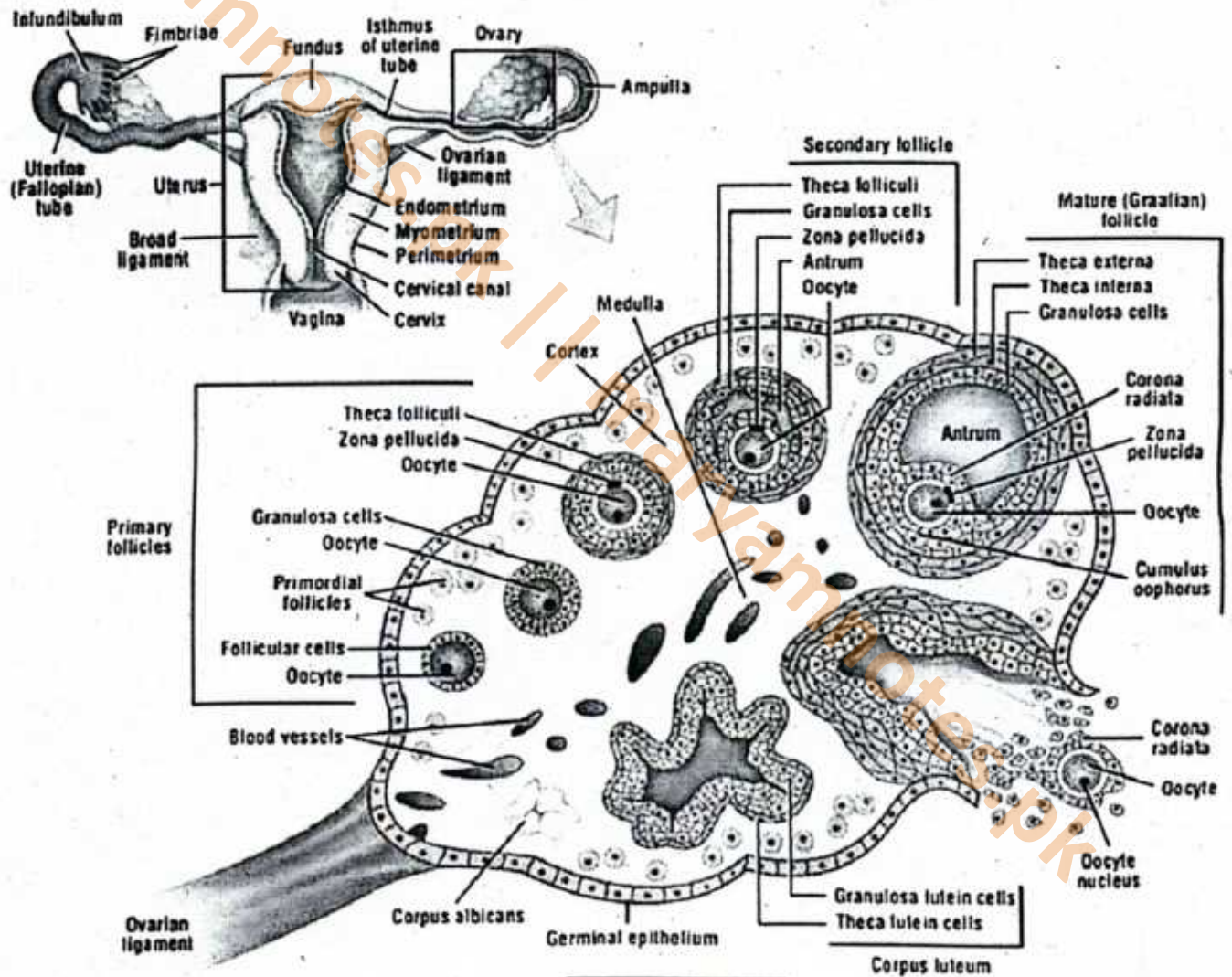
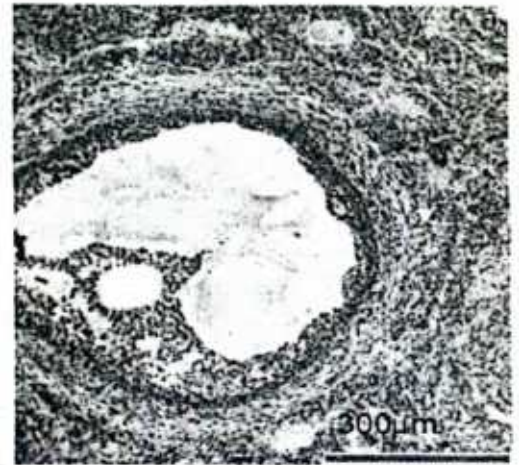
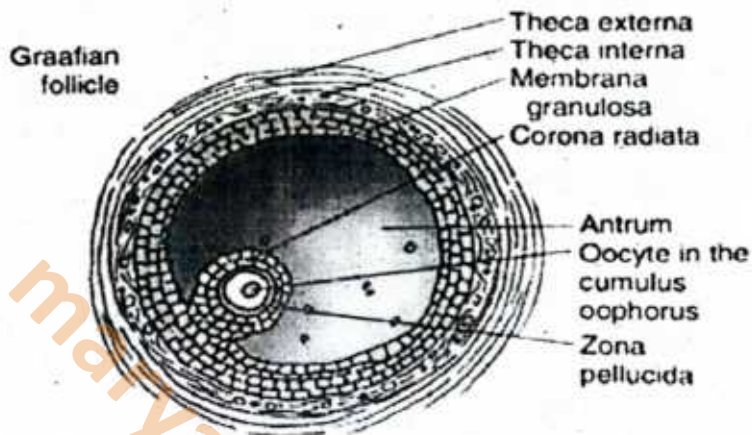
Graafian follicle is a fluid-filled structure in the mammalian ovary within which an ovum develops prior to ovulation.

- It was discovered by a Dutch anatomist R. de Graaf (1641–73).
- The secondary follicle develops into a **Graafian follicle**.
- The first meiotic division is now completed, and the oocyte is now a secondary oocyte, and starts its second meiotic division.
- After the first meiotic division, most of the cytoplasm goes into one of the two daughter cells. The other becomes the polar body (hard to see).
- Graafian follicle forms just before ovulation, typically around the 14th day of menstrual cycle.

Histology Of Graafian Follicle

The Histology Of Graafian Follicle reveals following structures under microscope from outside to inside:

- Theca folliculi:** The connective tissue capsule that surrounds the whole Graafian follicle (granulosa layer), consisting of two distinct layers:
- a. **Theca interna:** An inner, vascular, cellular layer.
 - b. **Theca externa:** An outer, fibrous connective tissue layer.
- Granulosa cell layer:** Multiple layers of cells that line the antrum.
- Antrum:** A large, fluid-filled cavity that makes up most of the follicle's volume.
- Cumulus Oophorus:** A mound of granulosa cells that holds the oocyte in place within the antrum. A mass of granulosa cells, called the cumulus oophorus, attaches to the follicle wall and surrounds the oocyte.
- Corona Radiata:** A crown of granulosa cells that covers the zona pellucida and is released with the oocyte at ovulation. The diminished cumulus oophorus surrounding the oocyte is called the corona radiata. It is during this stage that the primary oocyte completes the first meiotic division, extrudes the first polar body, and forms the second metaphase spindle. It is now in the secondary oocyte stage.
- Zona Pellucida:** An acellular layer that immediately surrounds the oocyte. the thick transparent membrane surrounding a mammalian ovum before implantation. The zona pellucida is secreted by the oocyte (immature egg cell) and the surrounding follicle cells.
- Oocyte:** The secondary oocyte is suspended off-center within the follicle. A secondary oocyte is an immature female gamete that is produced after the completion of the first meiotic division of a primary oocyte. It is a haploid cell that contains half the number of chromosomes, but each chromosome still has two chromatids. The secondary oocyte is released from the ovary during ovulation and will only complete the second meiotic division to form a mature ovum (egg cell) and a polar body if it is successfully fertilized by a sperm.
- Ovulation** involves rupture of the follicle and release of the secondary oocyte, with the corona radiata.
- Fertilization** provides the stimulus to complete the second meiotic division.



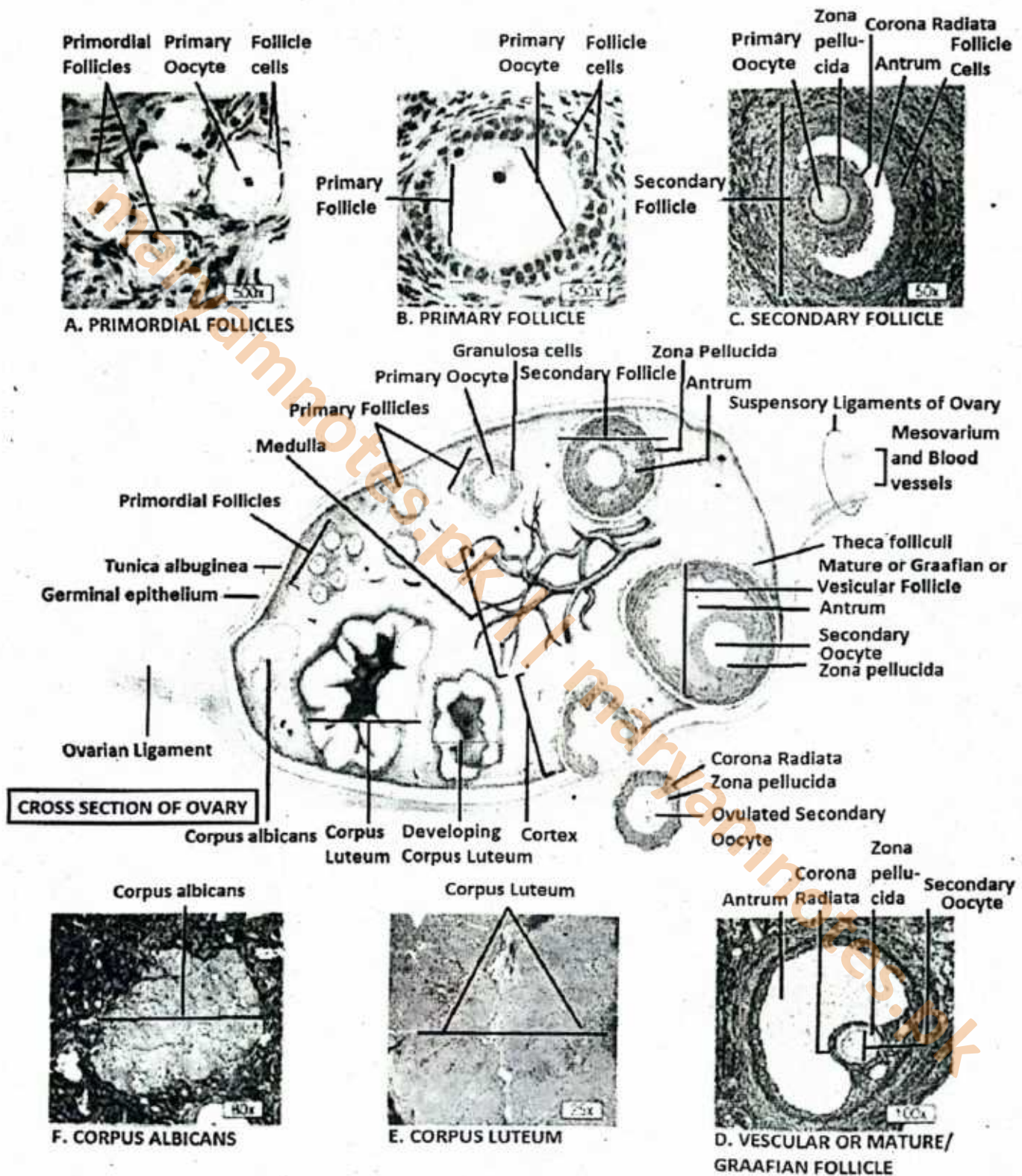


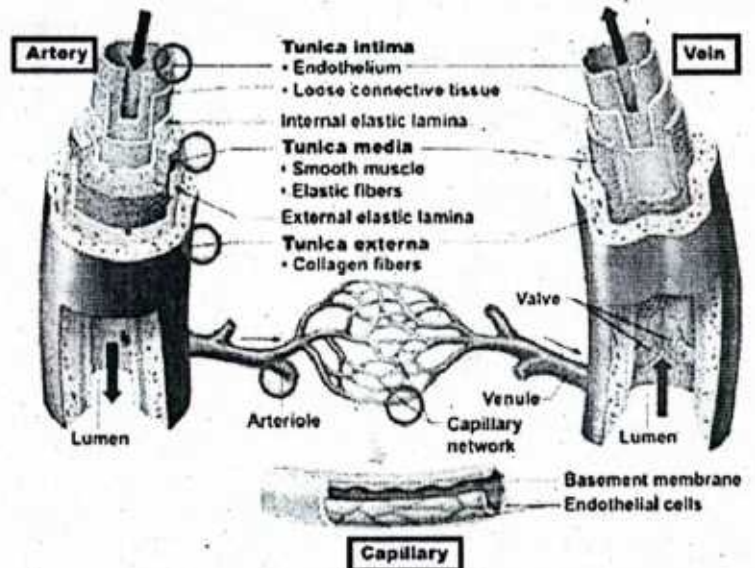
Figure: Folliculogenesis and Oogenesis in Human Ovary.

(C) T.S OF ARTERY, VEIN AND CAPILLARY

Observe prepared slide of T.S. of artery, vein and capillary one by one and examine under low and high power of microscope.

Observations

- In a closed circulation there are three types of vessel.
- **Arteries** carry blood away from the heart;
- **Veins** carry blood to the heart;
- **Capillaries** are much smaller that link arteries to veins and exchange of materials between blood and body cells occur here.
- The diameter of arteries and veins gradually diminishes as they get farther from the heart.
The smaller arteries are called **arterioles** and the smaller veins are called **venules**.



	T.S. OF ARTERY	T.S. OF VEIN	T.S. OF CAPILLARY
Layers	Each artery consists of 3 layers:	3 layers	Only one layer
i. Tunica externa	Outermost, connective tissue, collagen.	Same as artery	Absent
ii. Tunica media	More Smooth muscles and More elastic fibers. Thicker than vein.	Thinner, less muscular and less elastic fibers.	Absent
iii. Tunica intima	Inner layer squamous endothelium.	Same as artery	squamous endothelium
Bore	Thick walls with smaller bore.	Thin walled with larger bore.	Thin walled with small bore.

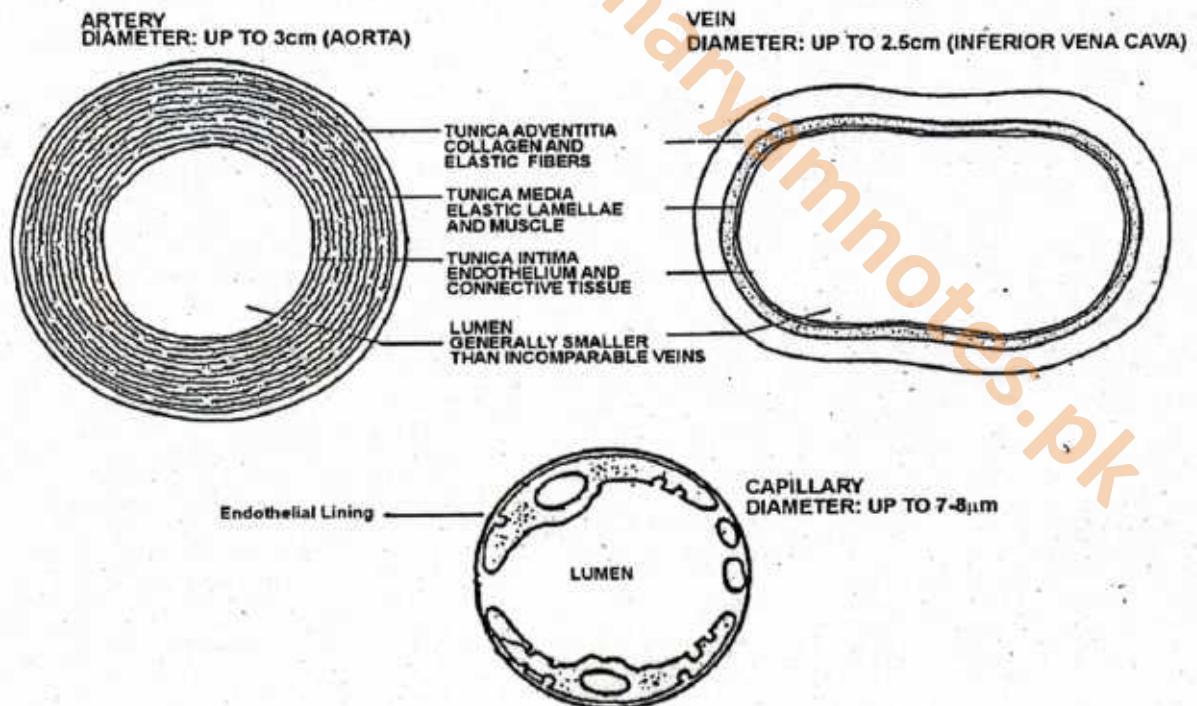


Table: Composition of arteries, veins and capillaries

ARTERIES	VEINS	CAPILLARIES
Thick muscular wall	Thin muscular wall	No muscle
Much elastic tissue	little elastic tissue	No elastic tissue
Small lumen relative to diameter	large lumen relative to diameter	large lumen relative to diameter
Capable of constriction	Not capable of constriction	Not capable of constriction
Not permeable	Not permeable	Permeable
Valves in aorta and pulmonary artery only	Valves throughout all veins	No valves
Transports blood from the heart	Transports blood to heart	Links arteries to veins
Oxygenated blood except in pulmonary artery	Deoxygenated blood except in pulmonary vein	Blood changes from oxygenated to deoxygenated
Blood under high pressure (10-16 kPa)	Blood under low pressure (1 kPa)	Blood pressure reducing (4 - 1 kPa)
Blood moves in pulses	No pulses	No pulses
Blood flows rapidly(+ 400 mm/sec)	Blood flows slowly(+ 150 mm/sec)	Blood flow slowing(+ 1 mm/sec)
Largest artery is aorta (3-4 cm in dia)	Largest vein is vena cava (2-4 cm)	Microscopic (7mm in dia)
Don't collapse when empty	collapse	Collapse
Lower surface area	Lower surface area	Larger surface area

(D) T.S OF PANCREAS (ISLETS OF LANGERHANS)

Observe prepared slide of T.S. of Pancreas (Islets of Langerhans) and examine under low and high power of microscope.

OBSERVATIONS

The pancreas is an endocrine (1-2%) as well as exocrine (98-99%) gland.

1. Serous acini (alveoli):- are numerous small lobules, closely packed secretory cells.

- The lobules are surrounded by blood vessels, ducts nerves & occasional Paccinian corpuscles.
- A pancreatic acinus consists of pyramidal shaped protein secreting zymogen cells.
- The secretory products from acini are drained by narrow intercalated ducts which then drain into interlobular ducts that are found in the connective tissue septa.

2. Pancreatic Islets:- With in masses of serous acini are found the isolated pancreatic islets (islets of Langerhans) which represent the endocrine component.

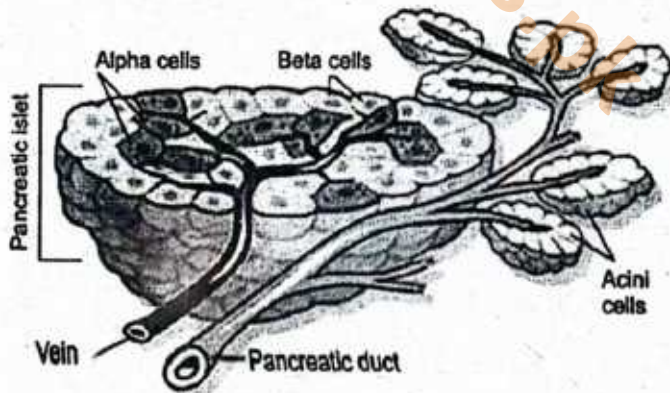
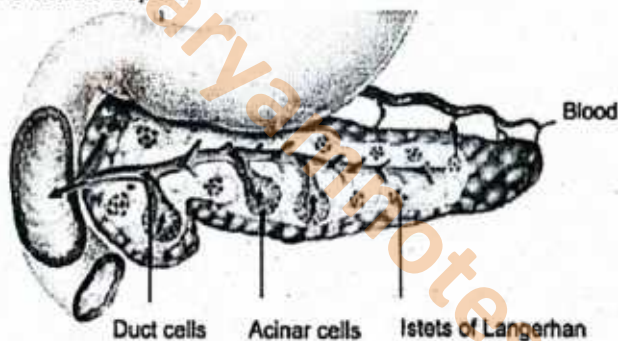
- Pancreatic islets are round masses of endocrine cells of varying size. They are larger than acini & appear as compact clusters of epithelial cells permeated by numerous capillaries.

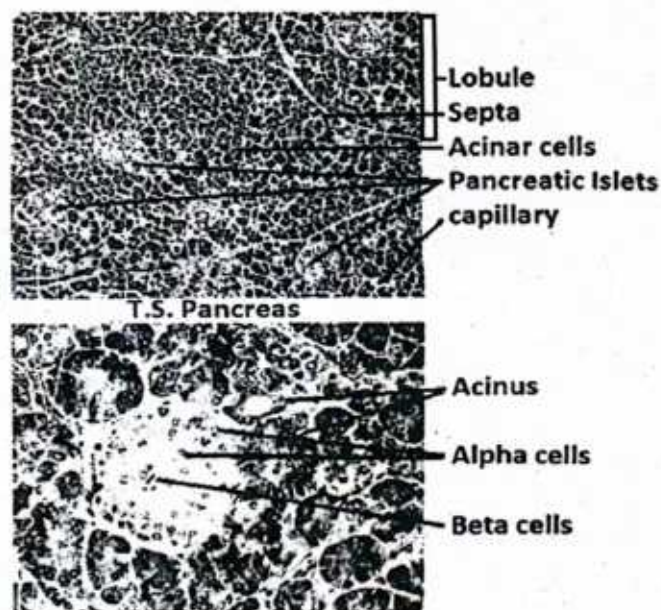
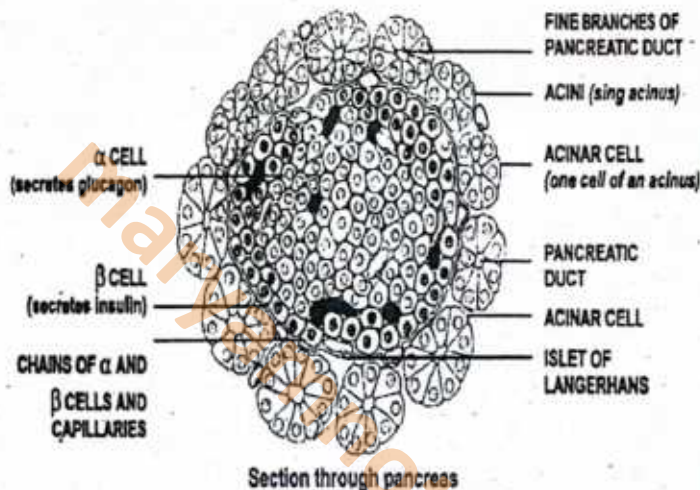
Alpha cells are:

- larger in size
- Stained pink (Cytoplasm) with hematoxylin.
- situated more peripherally in the islet
- secrete glucagon
- constitutes 30% of islets

Beta cells are:

- Smaller in size
- Stained Blue (Cytoplasm) with hematoxylin.
- situated more in center in the islet
- secrete insulin
- constitutes 70% of islets





POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1: Name different layers of the ovary?

Ans: Each ovary consists of 4 layers:

- i. Germinal epithelium - outermost layer. It is made of simple cuboidal cells.
- ii. Tunica albuginea - a collagenous Connective Tissue layer.
- iii. Cortex - outer layer.
- iv. Medulla - inner layer.

Q.2: What is Ovarian cycle?

Ans: The **ovarian cycle** is a set of predictable changes in a female's oocytes and ovarian follicles. During a woman's reproductive years, it is a roughly 28-day cycle that can be correlated with, but is not the same as, the menstrual cycle.

Q.3: What 2 types of processes are involved in Ovarian cycle?

Ans: i. Oogenesis (the production of female gametes) and
ii. Folliculogenesis (the growth and development of ovarian follicles).

Q.4: What are ovarian stem cells and how they produce oocyte?

Ans: **Oogenesis** begins with the ovarian stem cells, or **Stem Oogonia**. Oogonia are formed during fetal development, and divide via mitosis, much like spermatogonia in the testis. Unlike spermatogonia, however, oogonia form primary oocytes in the fetal ovary prior to birth. These primary oocytes are then arrested in this stage of meiosis I, only to resume it years later, beginning at puberty and continuing until the woman is near menopause (the cessation of a woman's reproductive functions). The number of primary oocytes present in the ovaries declines from **1 to 2 million in an infant**, to approximately **400,000 at puberty**, to **zero by the end of menopause**.

Q.5: How primary oocyte changes into secondary oocyte?

Ans: Just prior to ovulation, a surge of luteinizing hormone (LH) triggers the resumption of meiosis in a primary oocyte. This initiates the transition from **primary to secondary oocyte**. However, this cell division does not result in 2 identical cells i.e, cytoplasm is divided unequally, & one daughter cell is much larger than the other. This larger cell, **secondary oocyte**, at last leaves ovary during ovulation.

Q.6: What are polar bodies/cells; give their fate?

Ans: As primary oocyte divides, it gives rise to 2 cells. One larger cell is **secondary oocyte** and the smaller cell is called the first **polar body** that may or may not complete meiosis and produce second polar bodies; in either case, it eventually disintegrates. Therefore, even though oogenesis produces up to four cells, only one survives.

Q.7: How does the diploid secondary oocyte become an ovum—the haploid female gamete?

Ans: Secondary oocyte is arrested at Meiosis II (Metaphase II). Meiosis of a secondary oocyte is completed only if a sperm succeeds in penetrating its barriers. Meiosis II then resumes, producing one haploid ovum that, at the instant of fertilization by a (haploid) sperm, becomes the first diploid cell of the new offspring (a zygote). Thus, the ovum can be thought of as a brief, transitional, haploid stage between the diploid oocyte and diploid zygote.

Q.8: What is the significance behind the production of large size secondary oocyte?

Ans: The larger amount of cytoplasm contained in the female gamete is used to supply the developing zygote with nutrients during the period between fertilization and implantation into the uterus. Interestingly, sperm contribute only DNA at fertilization—not cytoplasm. Therefore, the cytoplasm and all of the cytoplasmic organelles (mitochondria etc) in the developing embryo are of maternal origin.

Q.9: What is meant by ovarian follicles and folliculogenesis?

Ans: Ovarian follicles are oocytes & their supporting cells. They grow & develop in a process folliculogenesis.

Q.10: What is meant by Primordial follicles?

Ans: Folliculogenesis begins with follicles in a resting state. These small **primordial follicles** are present in newborn females and are the prevailing follicle type in the adult ovary. Primordial follicles have only a single flat layer of support cells, called **granulosa cells**, that surround the oocyte, and they can stay in this resting state for years—some until right before menopause.

Q.11: In what sequence follicles progress during folliculogenesis?

Ans: Follicles progress from primordial, to primary, to secondary and tertiary stages prior to ovulation.

Q.12: What is meant by Primary follicles?

Ans: After puberty, a few primordial follicles will respond to a recruitment signal each day, and will join a pool of immature growing follicles called **primary follicles**. Primary follicles start with a single layer of **granulosa cells**, but the granulosa cells then become active and transition from a flat or squamous shape to a rounded, cuboidal shape as they increase in size and proliferate.

Q.13: What is meant by Secondary follicles?

Ans: As the granulosa cells divide, the follicles—now called **secondary follicles**—increase in diameter, adding a new outer layer of connective tissue, blood vessels, and **theca cells**—cells that work with the granulosa cells to produce estrogens.

Q.14: What is role of granulosa cells and theca cells?

Ans: **Theca cells** respond to luteinizing hormone (LH) and produce androgens, as well as progesterone in the pre-ovulatory large follicles.

Granulosa cells respond to follicle stimulating hormone (FSH) and produce estrogen. Granulosa cells impact follicle growth and ovulation.

Q.15: What is zona pellucida?

Ans: Within the growing secondary follicle, the primary oocyte now secretes a thin acellular membrane called the zona pellucida that will play a critical role in fertilization

Q.16: What is Antrum?

Ans: A thick fluid, called follicular fluid, that has formed between the granulosa cells also begins to collect into one large pool, or **antrum**.

Q.17: What is Tertiary or Vesicular or Mature Or Graafian follicle?

Ans: Follicles in which the antrum has become large and fully formed are considered **tertiary follicles** (or antral follicles). Several follicles reach the tertiary stage at the same time, and most of these will undergo **atresia**. The one that does not die will continue to grow and develop until ovulation, when it will expel its secondary oocyte surrounded by several layers of granulosa cells from ovary (Ovulation)

Q.18: How much time is required to reach at Tertiary follicle stage from primordial follicle?

Ans: Process of development from primordial follicle to early tertiary follicle, takes approx. 2 months in human

Q.19: Which hormone/s is/are secreted by Graafian follicle?

Ans: The Graafian follicle primarily secretes **estrogen**. As it matures, it produces increasing levels of estrogen, which is the main female sex hormone responsible for the development of secondary sexual characteristics. The follicle also secretes **inhibin**, which helps regulate the menstrual cycle.

Q.20: What are the functions of Graafian follicle?

Ans: The Graafian follicle's main functions are to mature and release a fertilizable egg during ovulation, secrete estrogen to regulate the menstrual cycle, and then transform into the corpus luteum to produce progesterone for potential embryo implantation. It also forms a protective environment for the oocyte and provides chemical communication between its cells and the oocyte itself.

Q.21: What are the functions of sertoli cells?

Ans: Sertoli cells cover about 7% of tubular cells in seminiferous tubules and perform following roles:

- Forms the BTB (blood - testis barrier)
- Produces androgen binding protein (ABP)
- Nourishes & protects developing sperm cells.
- Also produce inhibin
- Contains receptors for FSH and androgens (FSH and androgen aren't present on sperm). It indirectly helps the process of spermatogenesis.

Q.22: What is vas deferens?

Ans: Also called ductus deferens (pl; vasa deferentia) are 30 - 40 cm long tubular structure from tail of epididymis to prostatic urethra; distal vas deferens joins seminal vesicle to form ejaculatory duct.

Q.23: What are vasa efferentia?

Ans: Vasa efferentia are small, convoluted tubes in the male reproductive system that transport sperm from the testes to the epididymis. These ducts contain ciliated cells that help move the sperm along, and their function is crucial for sperm maturation, which occurs in the epididymis. They are also known as intratesticular ducts.

Q.24: Which blood vessel has high and slower blood flow?

Ans: Aorta has highest blood flow which is 400-500 mm per second. Capillaries have slowest blood flow which is about 1 mm/sec

Q.25: In which blood vessels the wave of blood pressure or pulse is detected?

Ans: The wave of blood pressure or pulse is detected in arteries.

Q.26: What is the function of arteries?

Ans: These transport blood away from the heart to the various parts of the body through capillaries.

Q.27: What is the function of veins?

Ans: These collect blood from body through capillaries and transport it towards heart.

Q.28: How arteries and veins differ in muscle layer and elastic fibres?

Ans: Arteries have thick muscle layer & elastic fibres while veins have thin muscle layer & less elastic fibres.

Q.29: Name the valves which are present in the veins?

Ans: The semi-lunar valves are present in the veins.

Q.30: In which vessels pulse is felt?

Ans: Pulse is felt only in arteries, which are primarily close to the skin.

Q.31: What is endocrine system?

Ans: The system consisting of cells, tissues and organs that synthesize and secrete hormones into the blood and lymphatic capillaries.

Q.32: Differentiate between 2 major types of glands?

Ans: (i) Endocrine glands (ii) Exocrine glands

Q.33: Give examples of endocrine glands?

Ans: (i) Pituitary gland (ii) Thyroid gland (iii) Parathyroid glands (iv) Adrenal glands

Q.34: Give examples of exocrine glands?

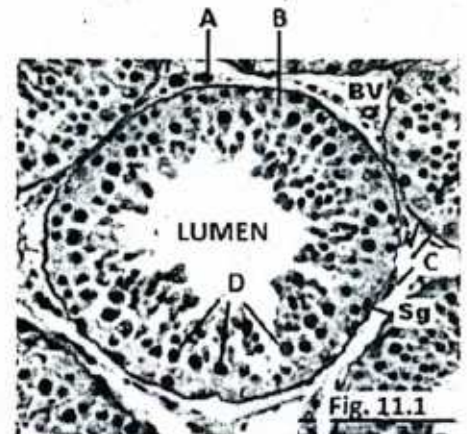
Ans: (i) Salivary glands (ii) Liver (iii) Pancreas

Q.35: Which glands are endocrine as well as exocrine in function?

Ans: Pancreas, testes and ovaries.

Q.36: What are the major cells of pancreatic islets (islets of Langerhans) and how would you distinguish them?

Ans: (i) the cytoplasm of alpha cells stains pink while the cytoplasm of beta cells stains blue.
(ii) The alpha cells are situated more peripherally in the islet and the beta cells deeper or more in centre of islet.

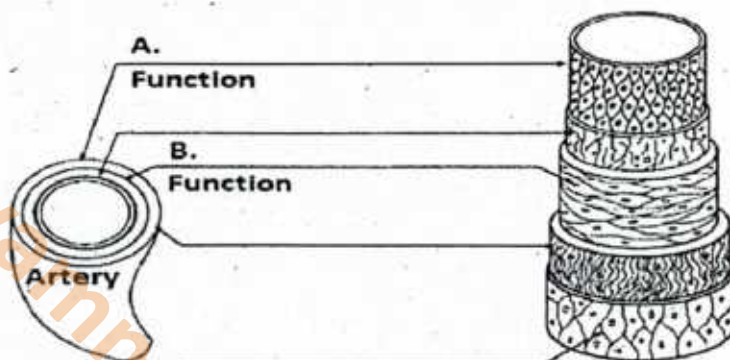
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1**(1) Given below is Transverse section of a tubular structure:****(i) Identify the figure 11.1 ; Label its parts A,B & D: (2)****Ans:****(ii) Identify the Labeled parts A & C; Give their role: (2)****Ans:****PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2****Given diagram is cross section of an ovarian Follicle.****(i) Label the following parts:**

Ans: A. _____
 B. _____
 C. _____
 D. _____

(2)**(ii) Compare the composition and function of labelled part A and C?:****(2)****Ans:**

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3

- (i) Given in the diagram is cross section of an artery; label its parts A and B. Also give the function of A and B: (2)

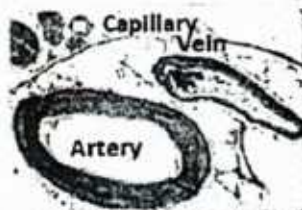


- (ii) Given in the diagram is L.S. of vein showing valves and blood flow. Why veins have valves? (1)



Ans: _____

- (iii) Given in the diagram is C.S. of blood vessels; Why veins and capillaries collapse when empty while arteries do not?: (1)



Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 4

(i) Identify the diagram; also give the role of alpha and beta cells.

(2)

Ans:



(ii) Draw a line diagram of islets of Langerhans:

(2)

Ans:

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Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) **Figure 11.1:** T.S of seminiferous tubule
A: Leydig cells **B:** Sertoli cells **D:** Spermatocytes (Primary)
- (ii) **A:** Leydig cells: They can synthesize and secrete Testosterone in response to ICSH.
C: Myoid cells: Myoid cells are specialized smooth muscle cells that surround seminiferous tubules in the testes. Their primary function is to contract, which helps to propel testicular fluid and developing sperm cells through the tubules.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

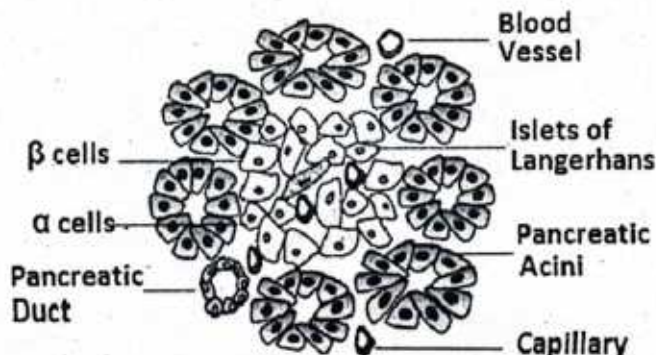
- (i) **A.** Theca cells, **B.** Antrum, **C.** Oocyte, **D.** Granular cells.
- (ii) **A.** **Theca cells** respond to luteinizing hormone (LH) and produce androgens, as well as progesterone in the pre-ovulatory large follicles.
C. **Secondary oocyte** is a resultant oocyte after meiosis I is done and is arrested at metaphase II before ovulation. It gives birth to ootid and ovum (egg cell) when meiosis II is completed.

Solution: Practical Based Assessment (PBA) Sample Paper- 3

- (i) **A.** Tunica interna (Endothelium)
Function: slick surface for blood flow.
B. Tunica media (Muscle and elastic layer)
Function: Regulate blood flow by contracting (vasoconstriction) and relaxing (vasodilation).
- (ii) The blood that flows through veins is under less pressure. Hence, there is always the possibility of backflow. Veins have valves to prevent this backflow of blood. Valves ensure that blood flows only in one direction through veins.
- (iii) Veins have thinner walls and less smooth muscle and elastic tissue compared to arteries while capillaries lack these tissues. So they collapse under external pressure while arteries do not.

Solution: Practical Based Assessment (PBA) Sample Paper- 4

- (i) **Cross section of Pancreas** (islets of Langerhans)
Alpha cells are involved in secretion of a hormone called Glucagon.
Beta cells are involved in secretion of a hormone called Insulin,
- (ii)



EXPERIMENT

12

PREPARATION OF TEMPORARY SLIDES OF ANIMAL CELLS USING DIFFERENTIAL STAINING AND THEIR IDENTIFICATION UNDER LIGHT MICROSCOPE

(A) SQUAMOUS EPITHELIUM/SKIN OF FROG

Performance-I

APPARATUS

- | | | | |
|--------------------|--------------------------|----------------------------|-----------|
| • Microscope | • Glass slides | • Cover slip | • Forceps |
| • scissors | • Scalpel/Knife | • Dropper | • Frog |
| • Distilled water | • Glycerine | • Blotting/tissue paper | |
| • Camel hair brush | • Bouin's fluid/Formalin | • Eosine or Methylene blue | |

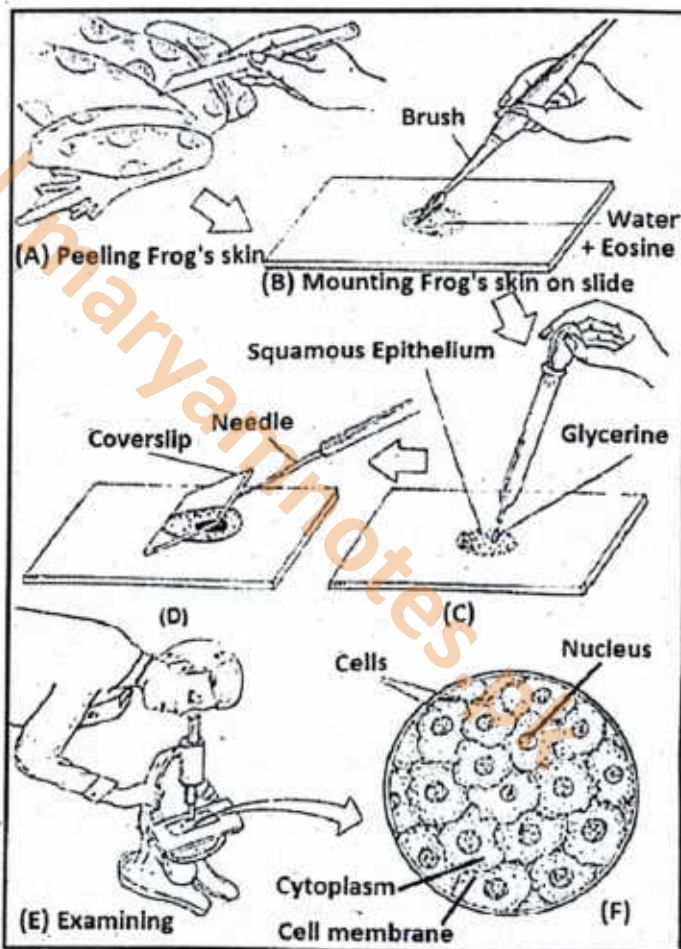
PROCEDURE

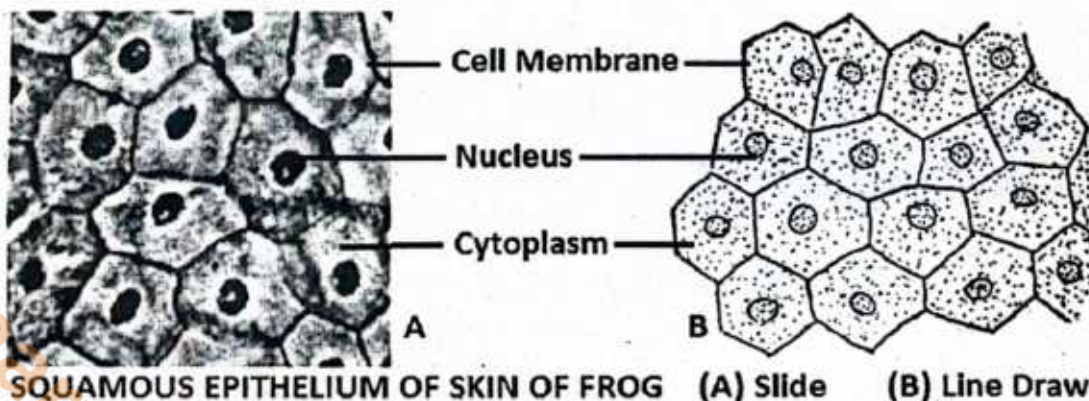
- An anesthetized or pithed frog is kept in water for 2 hours. After that a white membrane starts coming out of skin. If the frog is kept in 75% salt water then it is easily taken out.
- Excised skin tissue is immediately placed in a fixative solution, such as Formalin/Bouin's fluid, to preserve cells & prevent degradation.
- The membrane is removed with the help of a knife/scalpel and a piece is cut with the help of a pair of scissors and placed on a slide with the help of camel hair brush.
- 2 or 3 drops of Eosine solution or Methylene blue or iodine solution are placed on the slide and kept for 2 minutes; after that it is washed with tap water with the help of dropper.
- On another clean slide, 2 drops of glycerine are placed and with the help of a brush coloured epithelium is put on glycerine and on the top of it, a cover slip is placed.
- Now observe it under low and high power objectives of a light microscope.

OBSERVATIONS

The outermost layer of the skin of the frog casts is composed of the simple squamous epithelium. It is sometimes also called Stratum corneum. Under a microscope, these cells appear:

- large, flattened,
- Visible, central nucleus,
- somewhat hexagonal or irregularly round, resembling fish scales.
- Cells in the epidermis of tadpoles are ciliated in most of the frog species.





SQUAMOUS EPITHELIUM OF SKIN OF FROG (A) Slide (B) Line Draw

(A) BLOOD CELLS IDENTIFICATION FROM HUMAN BLOOD SMEAR

Performance-II

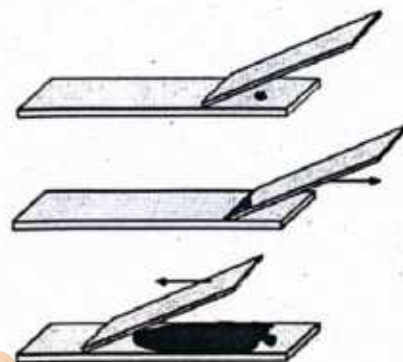
For example, **Wright-Giemsa stain**, with its combination of acidic and basic dyes, will differentially stain the granules, cytoplasm, and nuclei of various blood cell types.

APPARATUS

- Microscope
- Cover slip
- dropper bottles or pipettes
- blotting or tissue paper
- Glass slide
- staining rack
- Blood of human
- Alternately a prepared slide of Human blood cells may be used
- staining dishes / small jars
- distilled or deionized water
- One Step Wrights Stain

PROCEDURE

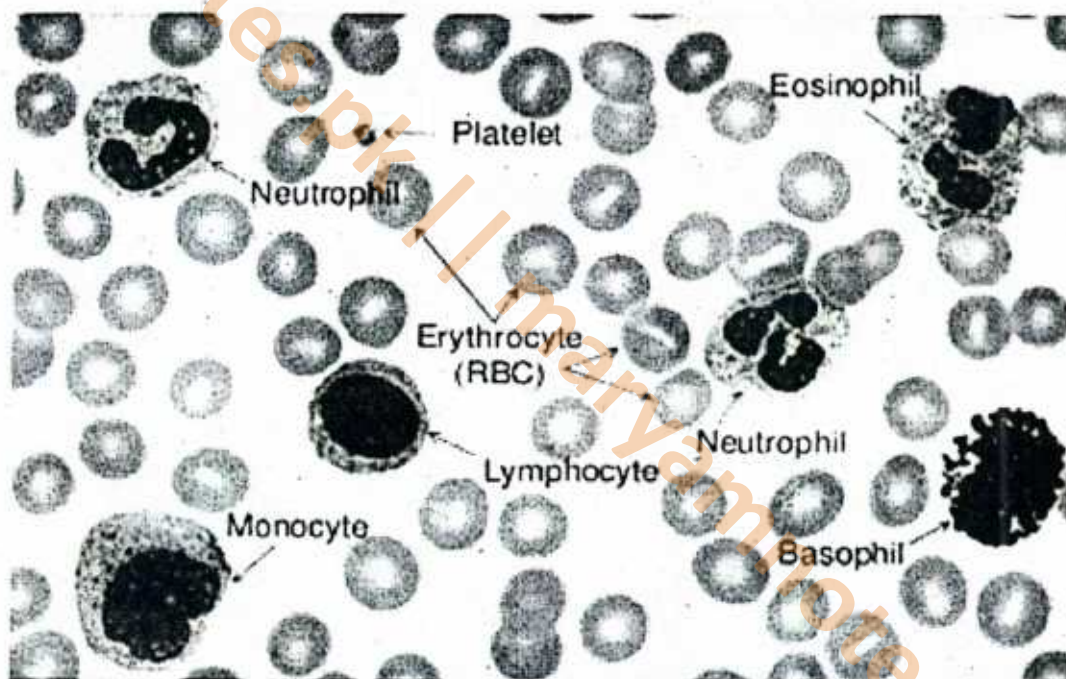
- Put a small drop of blood on the end of clean slide.
- Make a smear or thin film of blood on the slide by rolling other slide by spreading along its edge at an angle of 45° .
- Let the smear dry in air in vertical position.
- **Staining:** Dip air dried slides in One Step Wrights Stain for 15 – 30 seconds.
- So as to remove the stain, again dip the slide in distilled or deionized water in container 2 for 15 – 45 seconds and again let the slide dry vertically.
- Now apply oil and examine microscopically.



OBSERVATIONS

Sr. No	Differential staining of different blood cells		
1	Red Blood Cells, (RBCs)	Cytoplasm = orange – pink to rose	
2	Lymphocytes	Cytoplasm = light blue	Nucleus = deep blue – violet
3	Eosinophils:		Granules = orange to pink
4	Monocytes	Cytoplasm = pale gray – blue	Nucleus = deep bluish – purple
5	Neutrophils	Cytoplasm = pale pink	Nucleus = deep blue – violet
6	Basophils		Granules = deep blue to violet
7	Platelets		Granules (Central) = red – purple surrounded by light blue

RED BLOOD CELLS (ERYTHROCYTES)	WHITE BLOOD CELLS (LEUCOCYTES)					PLATELETS (THROMBOCYTES)
	GRANULOCYTES			AGRANULOCYTES		
						
ERYTHROCYTES	NEUTROPHIL	EOSINOPHIL	BASOPHIL	MONOCYTE	LYMPHOCYTE	PLATELETS
No Nucleus	Multi-lobed nucleus	Bi-lobed nucleus	Bi-lobed nucleus (Usually can't be seen)	Kidney shaped Nucleus (May appear lobed)	Large spherical Nucleus	No Nucleus
Biconcave Round Reddish to pinkish in colour	Pale red and blue cytoplasmic granules	Dark pink stained cytoplasmic granules	Lots of dark purple stained cytoplasmic granules	No granules Cytoplasm is very faintly stained Blue	No granules Cytoplasm is very faintly stained Blue	No granules Irregular spindle shaped fragments



(B) EPITHELIAL LINING/CELLS OF HUMAN ORAL CAVITY (HUMAN CHEEK CELLS)

APPARATUS

- Microscope
- Cover slip
- Dropper bottles or pipettes
- Field's stain A and Field's stain B.
- Glass slide
- Distilled or deionized water
- Blotting or tissue paper
- Tooth-picks
- Glycerine
- Cheek cells

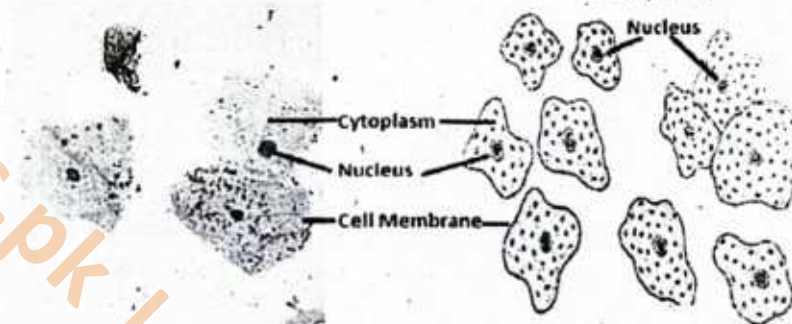
(Field stain A which is methylene blue which is the basic component of the stain and Field stain B made up of Eosin which is the Acidic component of the stain).

PROCEDURE

- Rinse your mouth to remove any food particles.
- Gently scrape the inner side of the cheek using a toothpick, which will collect some cheek cells.
- Place the cells on a glass slide that has few drops of Field's stain A on it.
- Mix the stain and the cheek cells using a needle and spread them gently.
- After 2-3 minutes remove the stain from the slide using a blotting paper.
- Take a few drops of Field's stain B using a dropper and put it on the slide for 2-3 minutes.
- After 2-3 minutes remove the stain from the slide using a blotting paper.
- Take a few drops of glycerine using a dropper on the slide.
- Take a clean cover slip and lower it carefully on the mixture with the aid of a needle.
- Using a brush and needle, press the cover slip gently to spread the epithelial cells.
- Remove any extra liquid around the cover slip using a blotting paper.
- Place this glass slide on the stage of the compound microscope and view it.

**OBSERVATIONS**

- Large number of flat polygonal cells with irregular boundaries attached edge to edge are seen.
- The cells have thin membrane called cell membrane which encloses jelly like substance called cytoplasm and a central nucleus.



RESULT: Cells under observation do not have cell wall and large prominent vacuole. So, cells of specimen on the slide are animal cells.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1 Why we use blood cells for staining?

Ans: White blood cells comprise a diverse collection of leukocytes. Blood cells can be microscopically, distinguished by gross morphology and by staining with cytochemical dyes.

Q.2 Name the stain used for staining the human cheek cell during the experiment.

Ans: Methylene blue.

Q.3 Even after staining of slide with methylene blue, certain cell organelles like mitochondria are not visible in the microscope. Why?

Ans: All cell organelles do not get stained with methylene blue, so they cannot be seen under microscope.

Q.4 Why is glycerine used for mounting of the human cheek cell?

Ans: Glycerine is hygroscopic in nature and hence, does not allow the cells to dry up.

Q.5 Why is teasing or spreading the cells important in case of cheek cell slide?

Ans: Teasing is important as it helps in proper dispersion of cells.

Q.6 Why is it essential to place the cover slip gently to avoid entry of air bubbles?

Ans: Entry of air bubbles on the slide should be avoided as these would mask the structure to be observed.

Q.7 Why are cheek epithelial cells always moist?

Ans: Due to presence of saliva.

Q.8 Why should you rinse your mouth before scrapping epithelial cells from inner side of cheek?

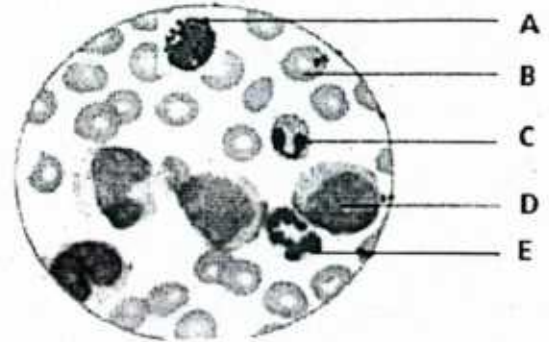
Ans: Rinsing helps in removal of any food particles left in the mouth and which may come with the cells.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Observe the photomicrograph of human blood.

(i) Label A, C, D, E. (2)

Ans: _____



(ii) Give one identification reason for any 2 of granulocyte. (1)

Ans: _____

(iii) Identify the agranulocytes leukocytes from the photomicrograph. (1)

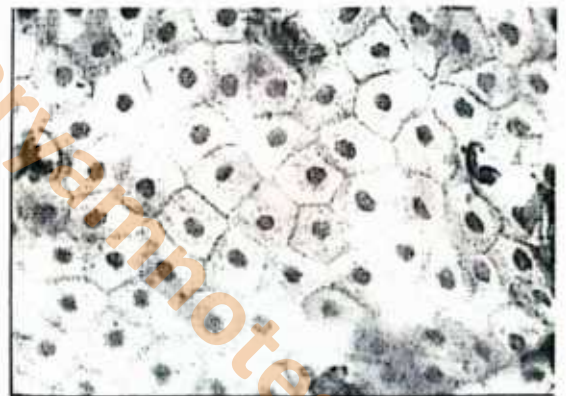
Ans: _____

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Given is the diagram of animal tissue.

(i) Identify the diagram; draw its line diagram: (2)

Ans: _____

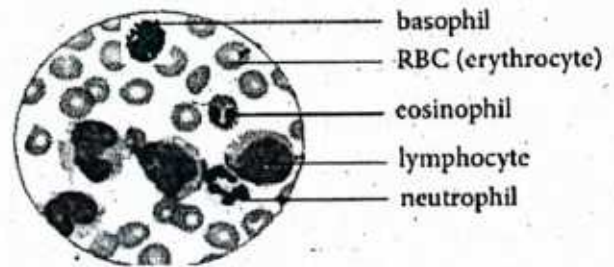


(ii) How these tissues are obtained and stained; give procedure. (2)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1

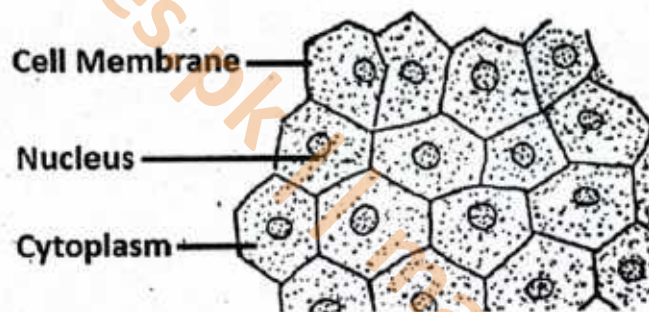
- (i) A. Basophil,
C. Eosinophil,
D. Lymphocyte
E. Neutrophil.



- (ii) Basophils: Bi-lobed to round Nucleus
Eosinophils: Bi-lobed Nucleus
Neutrophils: Multi-lobed nucleus
- (iii) Monocytes and lymphocytes.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- (i) Squamous epithelium (Skin) of Frog.



- (ii) Place a small drop of water in the center of a clean microscope slide. Gently peel or cut a small, very thin piece of the outer epidermal layer of the frog skin. Place that skin piece on slide and add 2-3 drop of Methylene blue. Place the coverslip to avoid trapping air bubbles. Place the slide on the microscope stage and observe under low and high power of magnification.

EXPERIMENT

13

PREPARATION OF TEMPORARY SLIDES OF PLANT CELLS AND THEIR IDENTIFICATION UNDER LIGHT MICROSCOPE

(A) LEAF EPIDERMIS (Stomata, Guard cells and Epidermal cells)

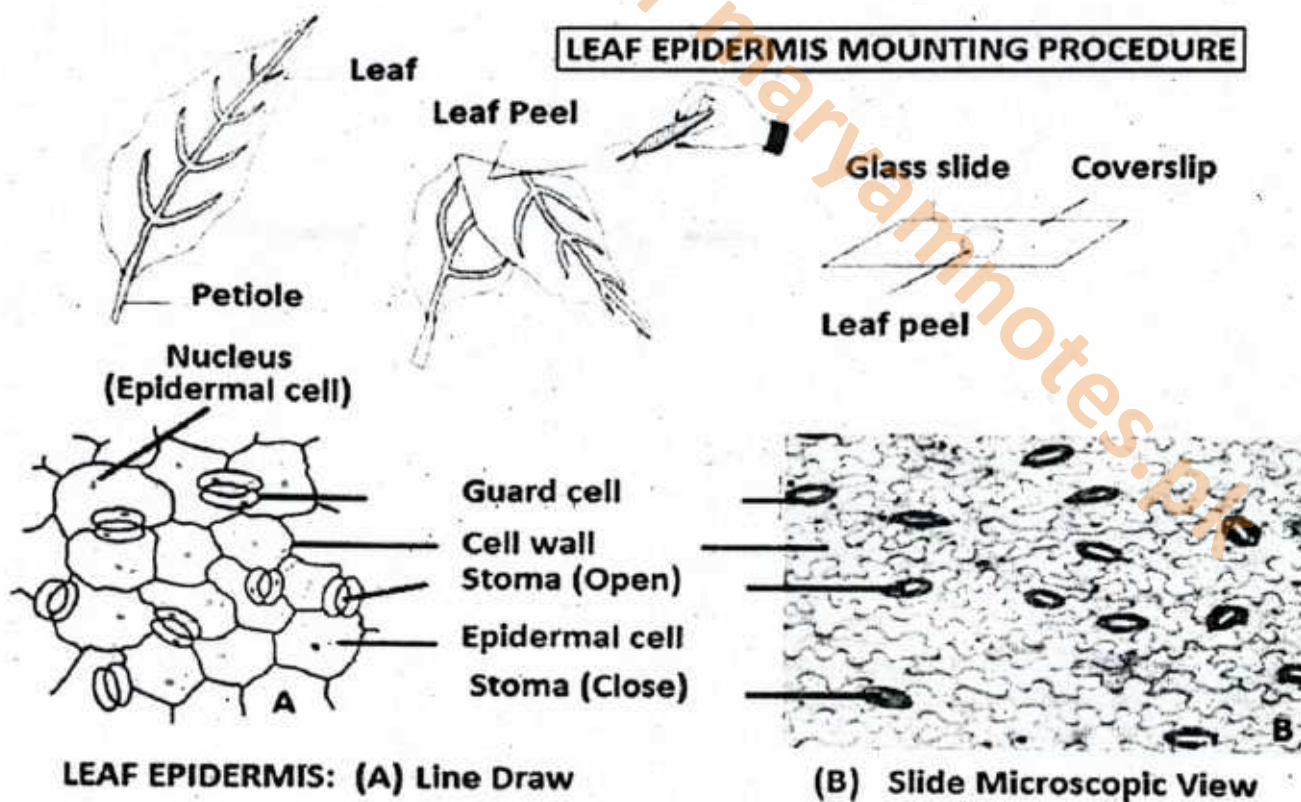
APPARATUS AND CHEMICALS:

- Forceps, • Needles, • Glass slides, • Dropper, • Coverslip,
- Brush, • Safranin, • Glycerine • Blotting paper, • Water,
- Compound microscope • A potted Tradescantia or Bryophyllum plant,

PROCEDURE:

1. Remove a healthy leaf from the potted plant.
2. Remove a part of the peel from the lower surface of the leaf. You can do this by folding the leaf over and gently pulling the peel apart using forceps. Tear off some epidermis, the transparent thin layer of surface cells.
3. Put a few drops of safranin stain on leaf epidermis on glass slide for 2-3 minutes.
5. Put a drop of glycerin over the peel and place a clean coverslip gently over it with the help of a needle.
6. Remove the excess stain and glycerin with the help of blotting paper.
7. Observe the slide under the low-power and high-power magnifications of the compound microscope.

LEAF EPIDERMIS MOUNTING PROCEDURE



OBSERVATIONS:

1. The epidermal cells are visible. These are irregular in outline and have no intercellular spaces.
2. Many small pores (stomata) are seen scattered among the epidermal cells.
3. Each pore is guarded by two bean-shaped guard cells, each containing chloroplasts and a nucleus.
4. The inner concave boundary of each guard cell is thick, whereas its outer boundary is thin.

Result:

Stomata are present in the epidermal cells of the lower surface of the leaf.

Precautions:

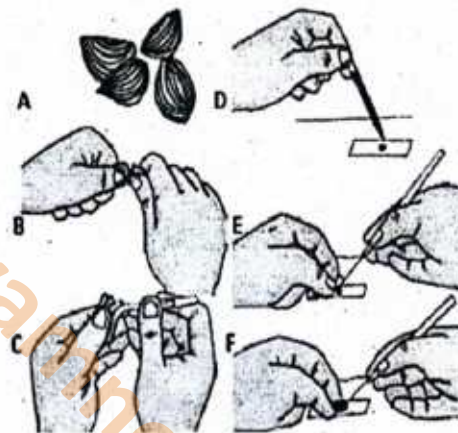
1. Cut the peel to a proper size and avoid folding it.
2. Always place the peel at the centre of the slide and hold the slide at the edges.
3. Do not overstrain or under strain the peel.
4. Always handle the peel with a brush as a needle may damage the cells.
5. Take care to prevent the peel from drying by using glycerin.
6. Place the coverslip gently, avoiding any air bubbles.
7. Remove excess stain and glycerin with a blotting paper.

(B) ONION EPIDERMAL CELLS (Onion Peel)**APPARATUS**

- | | | |
|--------------------------------|------------------|----------------|
| • Razor blades (single – edge) | • Onion | • Cover slip, |
| • Plain slides, | • Needles | • Forceps |
| • Safranin/Methylene blue | • Brush | • Watch glass, |
| • Compound microscope | • Blotting paper | • Glycerine |

PROCEDURE

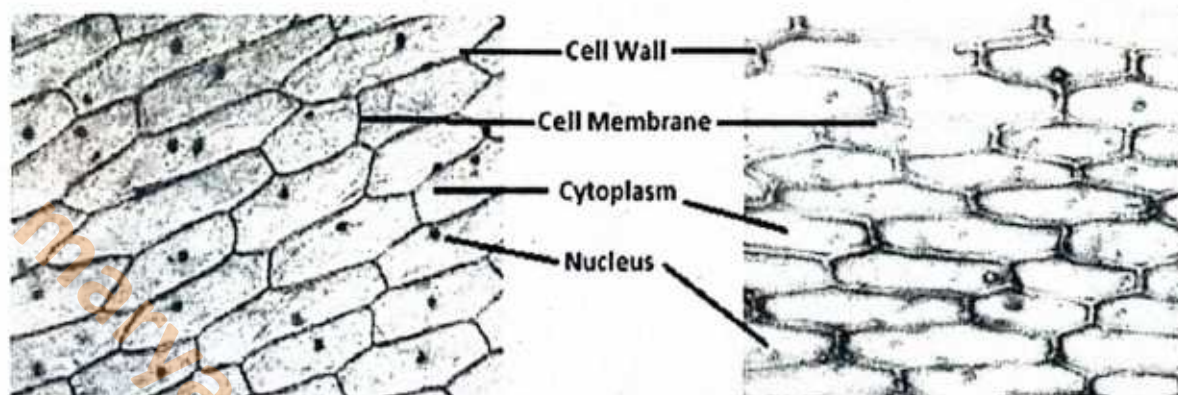
- Take a piece of onion and bend it to remove the transparent membranous structure called onion **epidermal peel**. With help of forceps remove the peel from its inner side.
- Place the peel in water in a watch glass.
- Add a few drops of stain safranin or methylene blue, to the watch glass containing the peel for staining.
- Now, wash the leaf peel with water and transfer it on to a clean slide with the help of brush.
- Remove extra water from the slide surrounding the peel with the help of blotting paper.
- To this slide, add a drop of glycerine over the peel and place the cover-slip in a manner to avoid entry of air bubbles.
- Soak away the extra glycerine with blotting paper.
- Examine slide under the microscope.

**OBSERVATIONS:**

- A large number of **rectangular cells & some hexagonal cells** with distinct cell wall can be observed
- **Cytoplasm** is seen as thin layer of deep coloured substance on inner surface of cell wall.
- A big central **vacuole** is present in the cell.
- A deeply stained **round body called nucleus** is seen in each cell.

CONCLUSION:

- The epidermal peel of onion comprises of rectangular shaped cells. Each cell comprises of a nucleus, a central vacuole, thin layer of cytoplasm and cell wall,
- As cell walls and large prominent vacuole are present in each cell, the cells placed under observation are plant cells.



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1: Compare the shapes of onion peel cells with human cheek cells.

Ans: Onion peel cells are rectangular in shape, having distinct cell walls whereas human cheek cells are flat polygonal cells with irregular boundaries.

Q.2: Why is the temporary mount slide mounted in glycerine?

Ans: In general mounting of material in the slide is done using glycerin. Glycerin has the capacity to remain moist for a long time and hence prevents the dehydration of the sample.

Q.3: How to differentiate between guard cells and epidermal cells?

Ans: Epidermal cells are irregular in shape, have no intercellular spaces and lack chloroplast. Guard cells are specialized cells and they are either kidney or dumb belled shaped, They are green as they contain many chloroplasts.

Q.4: How is the distribution of stomata in monocot leaves?

Ans: In monocot leaves, the stomata is equally distributed on lower and upper epidermis as they contain equal amounts of chloroplast and both surfaces perform equal amounts of photosynthesis.

Q.5: What is the shape and function of guard cells?

Ans: In dicot leaves the guard cells are kidney shaped, whereas in monocot leaves the guard cells are dumb-belled shaped. The function of guard cells is to protect the tiny pores and control the opening and closure of the stomata.

Q.6: Give examples of plants having kidney shaped stomata.

Ans: Banyan, Betel leaf plant, Peepal, Mango, etc.

Q.7: Give examples of plants having dumb- belled shaped stomata.

Ans: Banana, Grasses, Rice, Jowar, Bajra, etc.

Q.8: Why is safranin used for staining plant cells? Name the stain used for staining of onion peel.

Ans: Safranin is a red colored stain and stains lignin, suberin and other plant parts very easily.

Q.9: Which instrument can be used to know the size of stomata?

Ans: A porometer is used to know the size of the stomata.

Q.10: Which plant does not contain stomata?

Ans: Hydrilla does not contain stomata.

Q.11: What is the modification of stomata in gymnosperms and xerophytic plants?

Ans: In gymnosperms and xerophytic plants the stomata are sunken.

Q.12: Which part of the stomata contains chloroplast?

Ans: The guard cells of the stomata contain chloroplast.

Q.13: What is stomatal apparatus?

Ans: The stomata along with subsidiary cells are referred to as stomatal apparatus.

Q.14: Write about the size of the stomata.

Ans: The average breadth of stomata is 3-10 μm and the average length is 20-28 μm .

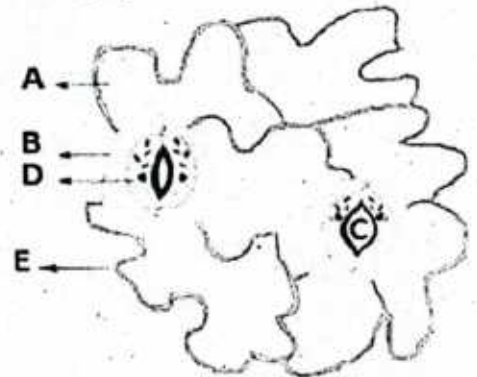
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Observe the given diagram of Leaf Epidermis carefully:

(i) Label A, B, C, D.

(2)

Ans:



(ii) To which group of plants this leaf epidermis diagram belongs and why?

(2)

Ans:

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Given is the diagram of animal tissue.

(i) Identify the diagram; draw its line diagram:

(2)

Ans:



(ii) How these tissues are obtained and stained; give procedure.

(2)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) A. Epidermal cell
B. Subsidiary cell
C. Stoma (Open)
D. Guard cell
- (ii) This leaf epidermis belongs to dicots.
Because in dicot leaves the guard cells are kidney shaped.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

- (i) Onion epidermis



- (ii) The onion epidermis procedure involves peeling a thin, transparent layer from an onion, placing it flat on a slide with a drop of water or stain (like safranin /iodine), adding a coverslip carefully to avoid bubbles, and observing under a microscope to see the cell wall, nucleus, and cytoplasm, typically starting with low power and increasing magnification.

EXPERIMENT

14

ABO AND Rh BLOOD GROUPS GENETICS

(A) IDENTIFICATION OF ABO AND Rh BLOOD GROUPS USING ANTISERA

THEORY (Principle of Test):

The ABO and Rh blood grouping system is based on agglutination reaction.

- Agglutination is the reaction between antigens present on red blood cells and antibodies present in serum resulting in visible clumping.
- Agglutination occurs if an antigen is mixed with its corresponding antibody, i.e. occurs when A antigen is mixed with anti-A or when B antigen is mixed with anti-B.

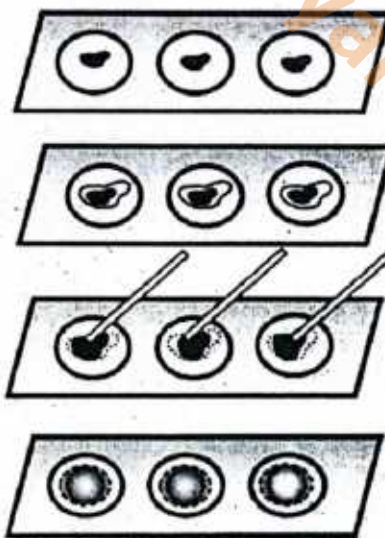
APPARATUS:

- Human blood
- Antiserum A, B and D
- Sterilized needle
- Microscope
- Glass slides
- Common pins
- Tooth picks



PROCEDURE:

1. Wear a lab. apron along with gloves to ensure safety.
2. Label three slides as A, B and D.
3. Take sterilized needle and prick the finger.
4. Put three blood droplets on each slide respectively.
5. Now add antiserum A, B and D on slides A, B and D respectively.
6. Take a tooth pick and mix the solution.
7. Observe it under microscope and note the observations.
8. Dispose of the materials according to the directions from your teacher.
9. Clean up your work area and wash your hands before leaving the lab.



1. Add three drops of blood in a clean glass slide

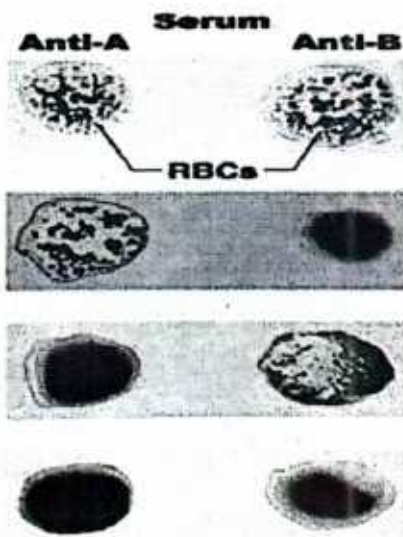
2. Add antisera A, B and D sequentially to the 1st, 2nd and 3rd drop of blood

3. Properly mix the antisera with the blood by separate toothpicks

4. Allow to stand for 2-3 minutes and note down the result on the basis of clump formation

RESULTS:

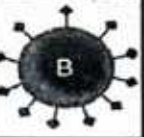
1. If the agglutination occurs in the RBCs to which both anti-A and B is added, then the blood group is '**AB**'.
2. If the agglutination occurs in the RBCs to which anti-A is added, then the blood group is '**A**'.
3. If agglutination occurs in the RBCs to which anti-B is added, then the blood group is '**B**'.
4. If there is no agglutination occurs in the RBCs, then the blood group is '**O**'.
5. If the agglutination occurs in the RBCs to which anti-D is added, then the blood type is **positive (+)** whereas if no agglutination occurs in the RBCs to which anti-D is added, then the blood type is **negative (-)**.

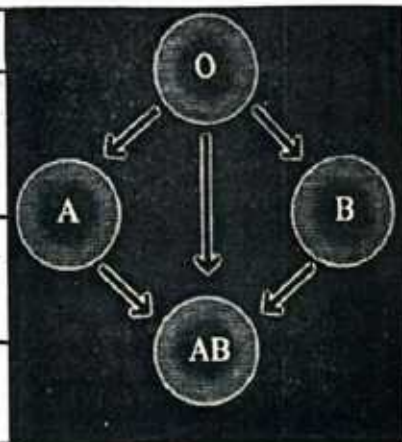
**OBSERVATION:****Results of Blood Groups:**

Result of Antiserum A,B and D on Agglutination detecting blood group:

Sr. No	Antiserum A	Antiserum B	Antiserum D	Blood Group
1	Agglutination	No Agglutination	Agglutination(Rh ⁺)	A ⁺
	Agglutination	No Agglutination	No Agglutination(Rh ⁻)	A ⁻
2	No Agglutination	Agglutination	Agglutination(Rh ⁺)	B ⁺
	No Agglutination	No Agglutination	No Agglutination(Rh ⁻)	B ⁻
3	Agglutination	Agglutination	Agglutination(Rh ⁺)	AB ⁺
	Agglutination	Agglutination	No Agglutination(Rh ⁻)	AB ⁻
4	No Agglutination	No Agglutination	Agglutination(Rh ⁺)	O ⁺
	No Agglutination	No Agglutination	No Agglutination(Rh ⁻)	O ⁻
Agglutination 		No Agglutination 		

Antigens and antibodies present in blood groups determining blood donors and recipients:

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None



(B) DETERMINATION OF CHILD'S BLOOD GROUP FROM THE PHENOTYPES AND GENOTYPES OF PARENTAL BLOOD GROUPS AND VICE VERSA

Codominance:

Some *alleles* are both expressed in the same phenotype, this is called codominance.

- Both codominant alleles are shown with upper case letters in genetic diagrams, but the letters used are different. The *gene* controlling human ABO blood groups has three alleles, not just two:

I^A and I^B are not *dominant* over one another BUT both are dominant over I^O

STEP 1 shows the possible genotypes (alleles present) and phenotypes (blood group).

This experiment demonstrates the principles of Mendelian genetics, showing how parental genotypes (allele combinations) determine offspring phenotypes (blood types).

To determine a child's blood group from parental blood types, you must first identify the possible alleles each parent can contribute and then use a Punnett square to cross all possible allele combinations.

Step 1: Determine possible parental genotypes:

- Blood Type A:** Can have genotype: $I^A I^A$ or $I^A I^O$.
- Blood Type B:** Can have genotype: $I^B I^B$ or $I^B I^O$.
- Blood Type AB:** Has genotype: $I^A I^B$.
- Blood Type O:** Has genotype: $I^O I^O$.

Step 2: Set up a Punnett square:

- Create a 2x2 grid.
- In the top row, list the possible alleles from one parent.
- In the leftmost column, list the possible alleles from the other parent.
- For example,** if the **mother is type A ($I^A I^O$)** and the **father is type B ($I^B I^O$)**.

Mother $\Rightarrow$	I^A	I^O
Father $\Downarrow$		
I^B	$I^A I^B$	$I^B I^O$
I^O	$I^A I^O$	$I^O I^O$

Step 3: Determine the child's genotype and phenotype:

- Fill in each box of the Punnett square by combining the alleles from the corresponding row and column. Each box represents a possible genotype for the child.
- Determine the blood type (phenotype) for each genotype as shown in step 1:

Step 4: Demonstrate the reverse (determining parental possibilities):

- If the child's blood type is known, you can work backward to determine the parents' possible genotypes. For example, if the child is blood type O ($I^O I^O$) then the both parents must have contributed I^O allele meaning that at least one parent must be blood type A ($I^A I^O$), B ($I^B I^O$), O ($I^O I^O$).
- This process can also help in paternity testing cases by excluding a potential father if their genotype cannot explain the child's blood type.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1: Define multiple alleles and state the alleles responsible for the traits of ABO blood groups.

Ans. Most genes actually exist in more than two allelic forms. Simply and conveniently such alleles that may exist in more than two different alternative forms are called "multiple alleles".

The ABO blood groups in humans are one example of multiple alleles.

- Blood group of a person depends upon the presence of antigens on the RBC.
- There are **4** major blood groups in man. Antigens are of **two** types i.e. Antigen A & Antigen B.
- It is now known that 3 alleles are responsible for this trait i.e. A, B and O.

Q.2: Why can multiple alleles provide many different phenotypes for a trait?

Ans. There are different forms of the same gene and affect similar organs or processes in the organisms. In short, multiple alleles are only variants of the same gene at the same locus.

For example: if a trait is controlled by 3 multiple alleles i.e. A_1 , A_2 and A_3 but every individual carries any two of them like A_1A_1 , A_1A_2 , A_1A_3 , A_2A_2 , A_2A_3 or A_3A_3 .

The ABO blood groups in humans are one example of multiple alleles.

Q.3: Describe the antigens of ABO blood group system.

Ans.

Blood Types	Genotypes	Antigen	Antibodies	Transfusions
Blood group "A".				
Homozygous	$I^A I^A$	A	B	A & O
Heterozygous	$I^A I$			
Blood group "B".				
Homozygous	$I^B I^B$	B	A	B & O
Heterozygous	$I^B I$			
Blood group "AB".	$I^A I^B$	AB	No	Any
Blood group "O".	II	No Antigen	A & B both	Only O

Q.4: Name various human blood group system.

Ans. There are more than **200** minor blood groups, **36** other known blood groups (belong to the rest of blood group system *other than ABO & Rh systems*) and 600 antigens that usually do not complicate the blood transfusions.

These are known as **Rare Blood Types**.

Examples of blood group systems other than "ABO" and "Rh" are MNS, P, Lutheran, Kell, Lewis, Duffy, Kidd, Diego etc. One example of such blood of group systems other than "ABO" and "Rh" is already given in co-dominance in the form of MN blood group system.

Q.5: Describe the antibodies of ABO blood group system.

Ans. See the table in Short Question #3 given above.

Q.6: Investigate the reasons for O^- (negative) individuals as universal donor & AB^+ (positive) as Universal recipient.

Ans. O blood group individuals are called universal donors and AB blood group individuals are called universal recipients because they can receive transfusion of blood from any of the four blood group. **AB blood** can be transfused only into AB recipients because they have neither anti A, nor anti B antibodies. **O blood** has neither A nor B antigens but it does have anti A and anti B antibodies. An O recipient can only be given transfusion from a donor O. Phenotype O can also be used as donor for small transfusion to A, B and AB recipients because donor's antibodies are quickly absorbed by other tissue or greatly diluted in recipient blood stream.

Q.7: Why a recessive group allele " I^O " is more frequent in population.

Ans. Because allele I not only expresses in homozygous condition (ii) but also it exists in heterozygous forms in 2 blood groups i.e, A and B ($I^A i$ and $I^B i$).

Q.8: Which blood group is called universal donors and universal recipients?

Ans. The blood group O^{-ve} (O negative) is actual universal donor because it has no antigen of ABO system and Rh system which can interfere with recipient's blood, whereas AB^{+ve} (AB positive) is actual universal recipient because it has neither anti-A and anti-B nor anti-Rh antibodies, therefore, it cannot resist any donor's blood.

Q.9: A man with type AB blood is married to a woman also with type AB blood. Show the cross. What proportion of their children will have:

- A. A blood _____ B. B blood _____
C. O blood _____ D. AB blood _____

Ans. A. A blood: 25% B. B blood: 25%
C. O blood: 0% D. AB blood: 50%

Mother ⇨	I^A	I^B
Father ↓		
I^A	$I^A I^A$	$I^A I^B$
I^B	$I^A I^B$	$I^B I^B$

Q.10: A man has type B blood (genotype BB) is married to a woman with type O blood. Show the cross. What proportion of their children will have:

- A. A blood _____ B. B blood _____
C. O blood _____ D. AB blood _____

Ans. A. A blood: 0% B. B blood: 100%
C. O blood: 0% D. AB blood: 0%

Mother ⇨	I^O	I^O
Father ↓		
I^B	$I^B I^O$	$I^B I^O$
I^B	$I^B I^O$	$I^B I^O$

Q.11: A woman with type A blood (genotype AO) is married to a type B person (genotype BO). Show the cross. What proportion of their children will have:

- A. A blood _____ B. B blood _____
C. O blood _____ D. AB blood _____

Ans. A. A blood: 25% B. B blood: 25%
C. O blood: 25% D. AB blood: 25%

Mother ⇨	I^A	I^O
Father ↓		
I^B	$I^A I^B$	$I^B I^O$
I^O	$I^A I^O$	$I^O I^O$

Q.12: A woman with type A blood is claiming that a man with type AB blood is the father of her child who is type B. Show ALL the possible crosses; remember that the woman can have AA or AO genotypes. Could this man be the father of the child? How? Assuming that he is the father, what must the mother's genotype be?

Ans. Blood group of child is B i.e, its genotype could be BB or BO. As mother is type A (AA, Ao) so she cannot contribute B allele to her child hence she can only contribute o allele to her child (confirming that is mother is heterozygous A blood group-Ao). So the child can only have its genotype BO and not BB.

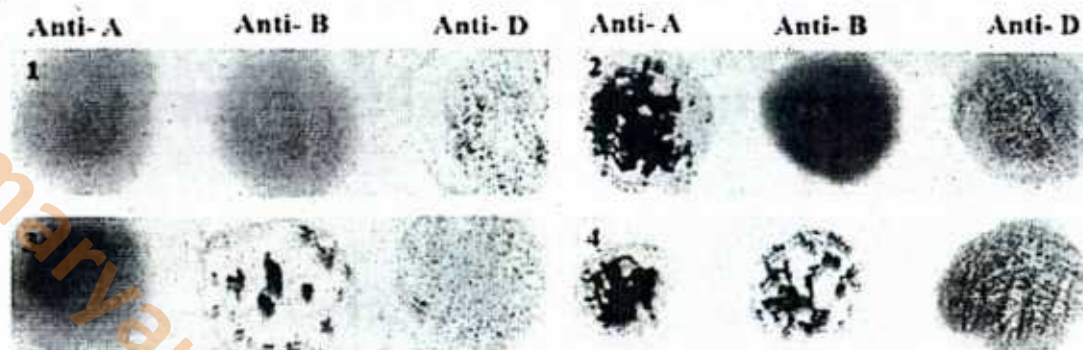
Mother ⇨	I^A	I^O
Father ↓		
I^A	$I^A I^A$	$I^A I^O$
I^B	$I^A I^B$	$I^B I^O$

Q.13: A woman is searching for her father and she has type O blood. She looks through records of men who could be her father. Which blood type can she eliminate from her search? (In other words, her dad CANNOT be what blood type.) Explain how you know this?

Ans. If woman is blood group O then she has only homozygous genotype $I^O I^O$. One allele I^O is contributed from her father and the other I^O is by mother. So in blood group types (as shown in table of Q.3) only the blood group $AB = I^A I^B$ cannot inherit allele I^O that's why she should eliminate the men with blood group $I^A I^B$.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER

Given in the diagram are slides of some person's blood group detection; answer the following questions:



(i) Identify the blood group of all 4 person in the slide: (2)

Ans: 1. _____ 2. _____ 3. _____ 4. _____

(ii) Give the reason of blood group of person 1 and 2: (1)

Ans: _____

(iii) Which cross can produce all 4 types of blood groups? Draw punnet's square to support your answer: (1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper

- (i) 1. O Negative 2. A Negative
 3. B Negative, 4. AB Positive
- (ii) 1. O Negative: No agglutination and hemolysis of blood took place in blood spots of slide 1.
 2. A Negative: Agglutination and hemolysis of blood only took place in first blood spots of slide 2.
- (iii) Cross between: $I^A i$ X $I^B i$

Mother ⇨	I^A	I^O
Father ⇩		
I^B	$I^A I^B$	$I^B I^O$
I^O	$I^A I^O$	$I^O I^O$

EXPERIMENT

15

TO IDENTIFY AND DRAW DIFFERENT PARTS OF SPOROPHYTE AND GAMETOPHYTE GENERATION OF A FERN PLANT (ADIANTUM) THROUGH PLANT SPECIMEN AND PREPARED SLIDES

STUDY OF FERN (Adiantum)

APPARATUS:

- Dissecting microscope
- Compound microscope
- Leaves
- Sori
- Sporophyte and gametophyte of Adiantum,
- Slides and cover slip.
- Prepared slide of T.S of the gametophyte

PROCEDURE

Study sporophyte and gametophyte of Adiantum and its different parts by hand lens and microscope.

OBSERVATIONS

A. Study of Sporophyte

- The plant body is sporophyte. It is dominant, conspicuous, photosynthetic and independent.
- It is a small herb. It consists of stem, roots and leaves.
Stem: It has short, thick and underground stem called rhizome.
Rhizome is protected by brownish scales called ramenta.
Roots: It has fibrous adventitious roots.
Leaves: It has pinnately compound leaves or fronds
Pinnæ arise directly from the rachis (first order).
Pinnules: Each pinna has many pinnules. Pinnules are leaflets of second order.
- **Sporangium:** The sporangia are present in groups called Sori. Each sorus has a number of sporangia covered by false indusium. Each sporangium is slightly flattened and consists of biconvex capsule and a multicellular stalk. Capsule is made up of 2 parts:
 - Annulus** is $\frac{3}{4}$ of the edge and is thick walled.
 - Stomium** is $\frac{1}{4}$ part and is thin walled.
 Sporangium produces spore (N) meiotically which form a haploid gametophyte or prothallus.

Reason for identification:

- Sporangium seems to be a flattened and has biconvex capsule and stalk.
- Compound leaves or fronds, Underground rhizome, Thick wall annulus cells are present.

B. Study of prothallus or Gametophyte

Prothallus is a small, flat, autotrophic and heart shaped structure.

A **notch** is present at the anterior end of the prothallus.

Prothallus is monoecious (bisexual)

Archegonia are present near the notch and contains an egg or oosphere.

Antheridia are scattered among the rhizoids and produces numerous spermatozoids.

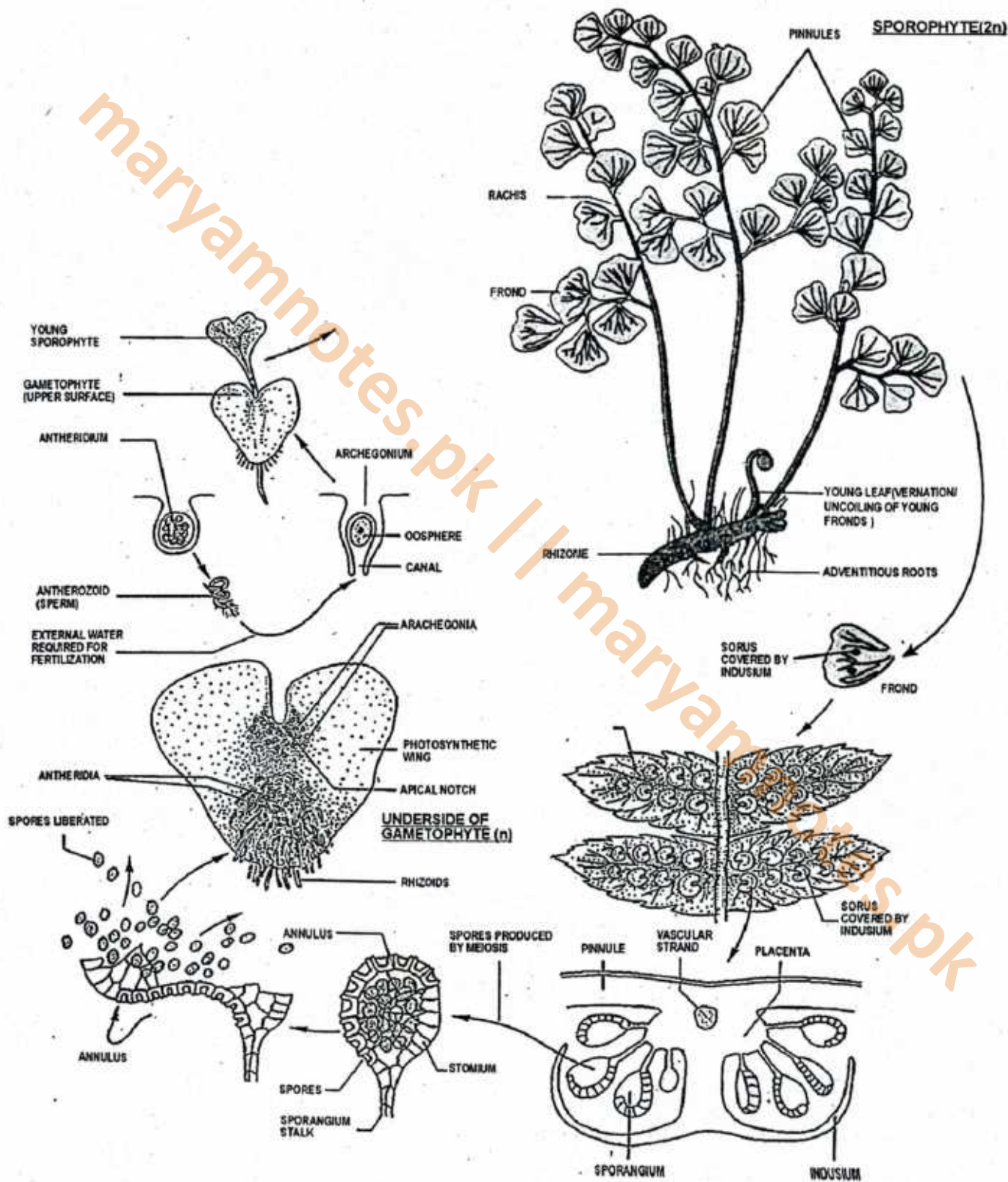
Spermatozoids or Antherozoids swim in water and reach the archegonium.

Fertilization occurs and oospore is formed.

The **oospore** grows to form sporophyte.

Reason for identification:

- Prothallus is small, flat and heart shape structure.
- Antheridia and archegonia are present.



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1) What is *Adiantum* often called?

Ans: *Adiantum caudatum* or the **maidenhair fern** is also known as the "**walking fern**". This is because its new plantlets grow wherever the arching leaves of the parent plant touch the ground, creating a walking effect. Shaded areas are its habitat.

2) What is a fern?

Ans: Fern is a vascular plant having body that is differentiated into root, stem and leaves.

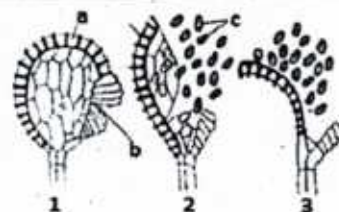
3) How can the sporophyte of pine be compared with that of fern with regard to size and mode of nutrition?

Ans: Both are independent and photosynthetic. The sporophyte of pine is much larger than that of the fern. Furthermore, the root system of pine is much more extensive.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

(i) Diagrams show stages of spore formation of *Adiantum*. Name the parts labeled a, and b. (2)

Ans:



(ii) Where the structure '1' is found. (1)

Ans:

(iii) What is prothallus? (1)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i) a. Annulus b. Stomium

(ii) in Sori

(iii) Prothallus is a small, flat, autotrophic and heart shaped structure gametophyte. A notch is present at the anterior end of the prothallus. Prothallus is monoecious (bisexual).

EXPERIMENT 16

TO STUDY THE STRUCTURE OF MALE AND FEMALE CONE OF PINUS

APPARATUS:

- Male and female cones
- Blade
- Dissecting and compound microscope
- Glass slide and cover slip

PROCEDURE

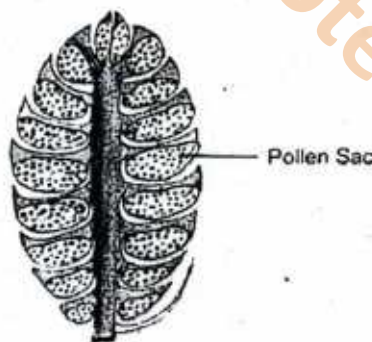
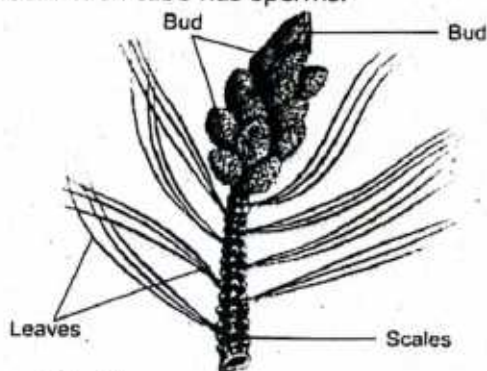
- External structure of male and female cones are observed with the help of hand lens or dissecting microscope.
- A scale of male cone is placed on slide. It is studied under compound microscope.
- Scale of female cone is observed with hand lens.
- Microspore is taken on slide. It is crushed. Microspores or pollen grains are observed under microscope.
- Similarly megaspore is studied by hand lens.



A: OBSERVATION OF MALE CONE

Male cone has small size. Following structures are observed in male cone.

1. **Microsporophylls:** Male cone has central axis. Many spirally arranged leaves are attached on this central axis. These leaves are called microsporophyll.
2. **Microsporangia or pollen sac:** Two microsporangia are attached on the lower surface of each microsporophyll.
3. **Microspores or pollen grain:** A large number of pollen grains are produced in each microsporangium. The pollen grain has two large air sacs. These air sacs help in the dispersal of microspore. Pollen grain reach the female gametophyte by wind.
4. **Pollen tube or male gametophyte:** Pollen grain germinates to produce male gametophyte in the form of pollen tube. Pollen tube has sperms.



Reasons for identification:

- Male cone has very small size with small microsporophyll.
- Spirally arranged sporophyll.
- Microsporangia are present under of surface of sporophylls.

B: OBSERVATION OF FEMALE CONE

Female cone is much larger than male cone. It consists of following parts:

1. **Megasporophylls:** Female cone has central axis. Many megasporophylls are attached on this central axis. These sporophylls are hard and woody. They are spirally arranged. Each sporophyll is composed of two scales. (a) Upper ovuliferous scales (b) Lower bract scale
2. **Ovule:** There are two depressions on the upper surface of each ovuliferous scales. Two (sporangia) are attached in these depressions.
3. **Megaspores:** Four megaspores are produced in each ovule by meiosis. Three megaspores degenerate. Only one functional megaspore is left.
4. **Female gametophyte:** The functional megaspore germinates to produce female gametophyte. Female gametophyte has archegonia. These archegonia have eggs.

Reason for identification:

- Female cone has large size. It has large scales.
- Ovules are present on scales.

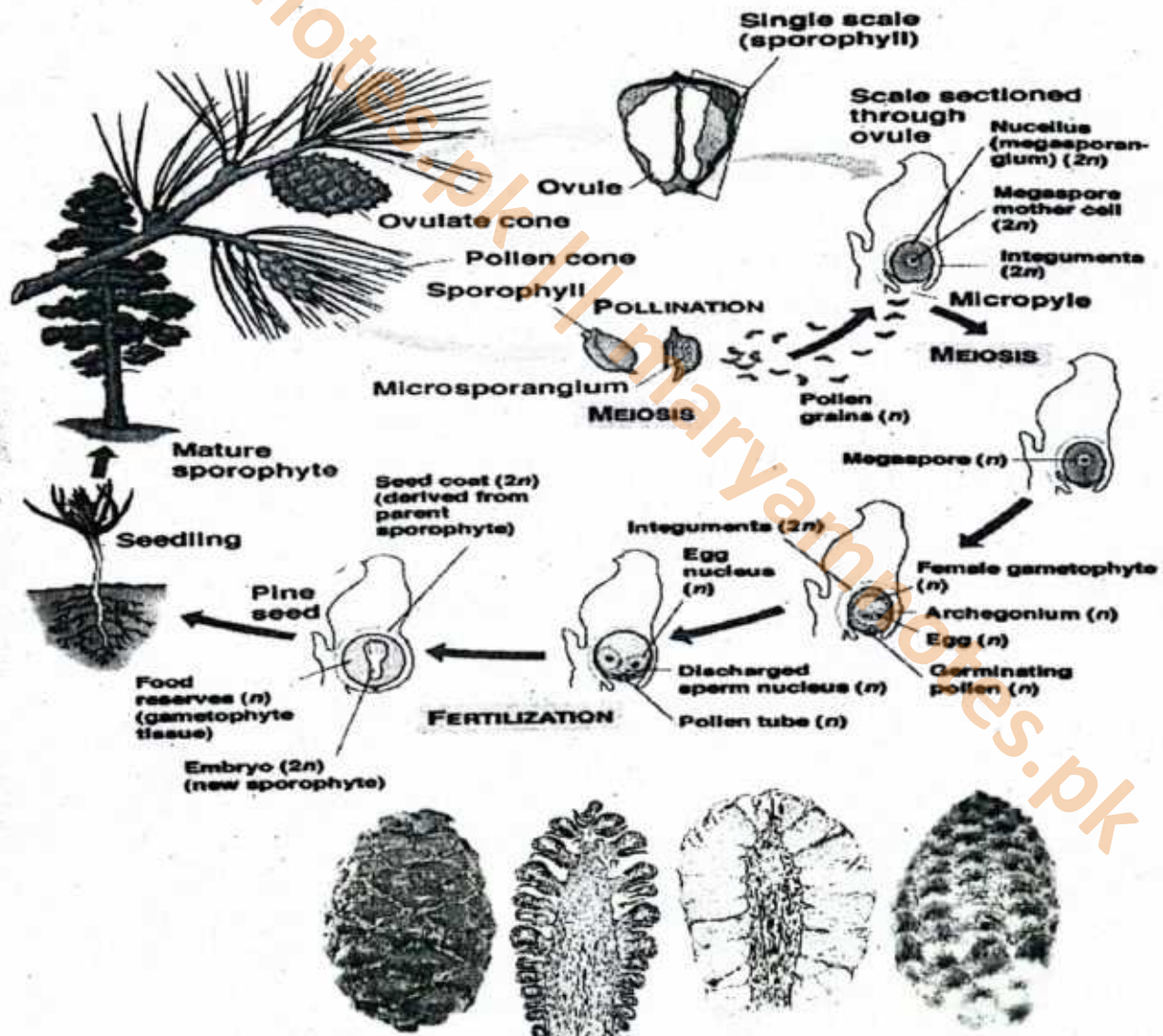
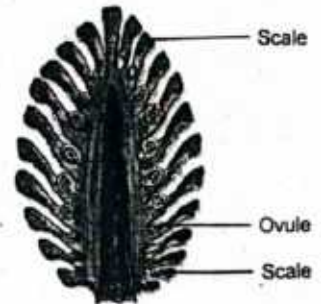


Figure: Female cone and its Cross section; Male cone and its Cross section

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1) What role do the bladders (wings) of the pollen grains of pine play?

Ans: The pollen grains of pine are required to be carried to the female cone by means of wind. The air-filled bladders make the pollen grains light so that they may easily float in the air.

2) Explain why it might be advantageous for the pine tree to produce more male cones than the female cones?

Ans: The pollination in pine takes place by wind. In this method there are greater chances of the wastage of pollen grains during transition. Hence in order to ensure pollination a very large number of pollen grains is required so that besides wastage, some may reach to the female cone. For producing numerous pollen grains the pine must have numerous male cones.

3) Which structures are produced within the microsporangium of the pine?

Ans: Pollen grains, also known as microspores are produced within the microsporangium of the pine.

4) What are the other names for the male and female cones of Pinus.

Ans: These are the pollen cones and seed cones respectively.

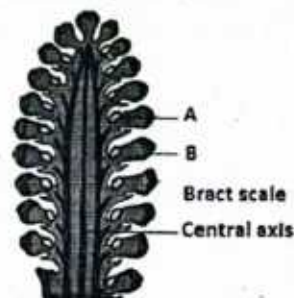
5) Which structures of Pinus give rise to the seeds?

Ans: The ovules of Pinus give rise to the seeds.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

(i) Given in the diagram is C.S. of female cone of Pinus; Label its parts A and B. What structure does part A form? (2)

Ans:



(ii) Differentiate between male and female cone: (2)

Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i) A. Ovule B. Ovuliferous scale

Ovule develops into seed.

(ii) Male cones are smaller, herbaceous, and clustered at the base of new shoots, producing vast amounts of pollen, while Female cones are larger, woody, and grow at the tips of shoots, where they eventually produce seeds. Male cones are ephemeral, withering after pollination, while female cones mature over several years.

EXPERIMENT 17

TO OBSERVE AND IDENTIFY THE CHARACTERISTICS OF REPRESENTATIVE VERTEBRATE ANIMALS (AMPHIBIANS, REPTILES, BIRDS AND MAMMALS) THROUGH PRESERVED ANIMAL SPECIMENS OR DIAGRAMS.

APPARATUS:

- Hand lens, dissecting and compound microscope
- Preserved slides and specimens

PROCEDURE

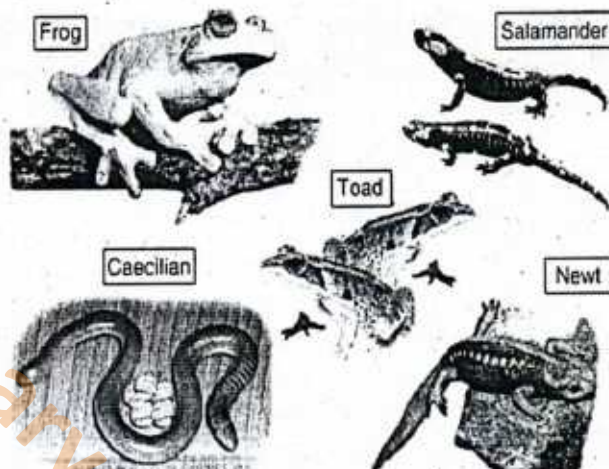
- Examine the specimens provided and follow the key given the next page.

CLASS AMPHIBIA

1. Skeleton is mostly bony.
2. They are tetrapods and have four limbs.
3. Skin is smooth and moist. It has many glands.
4. Respiration takes place by gills in larva and by lungs and skin in adults.
5. Heart is 3-chambered.
6. There is double circulation in heart.
7. Sexes are separate. Fertilization is external.
8. The larva changes into adult by metamorphosis.
9. Amphibians are cold blooded (Poikilothermic) animals.
10. They hibernate in winter.

Examples

Frog, Toad and Salamander

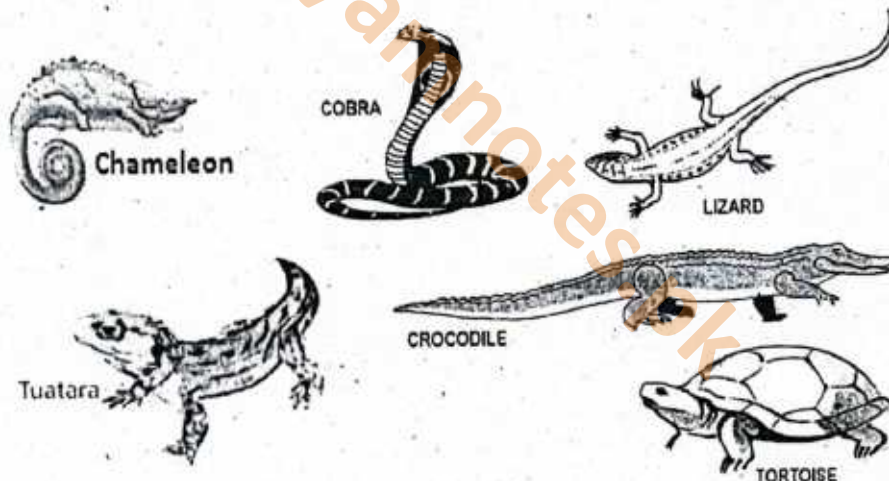


CLASS REPTILIA

1. The shell of egg is leathery.
2. Reptiles have dry scaly skin.
3. The ventricle of heart is incompletely partitioned.
4. Most reptiles have better developed limbs.
5. Reptiles are cold blooded.
6. They also hibernate in winter.

Examples

Snakes, Lizards, Tortoise, Turtles, Crocodile



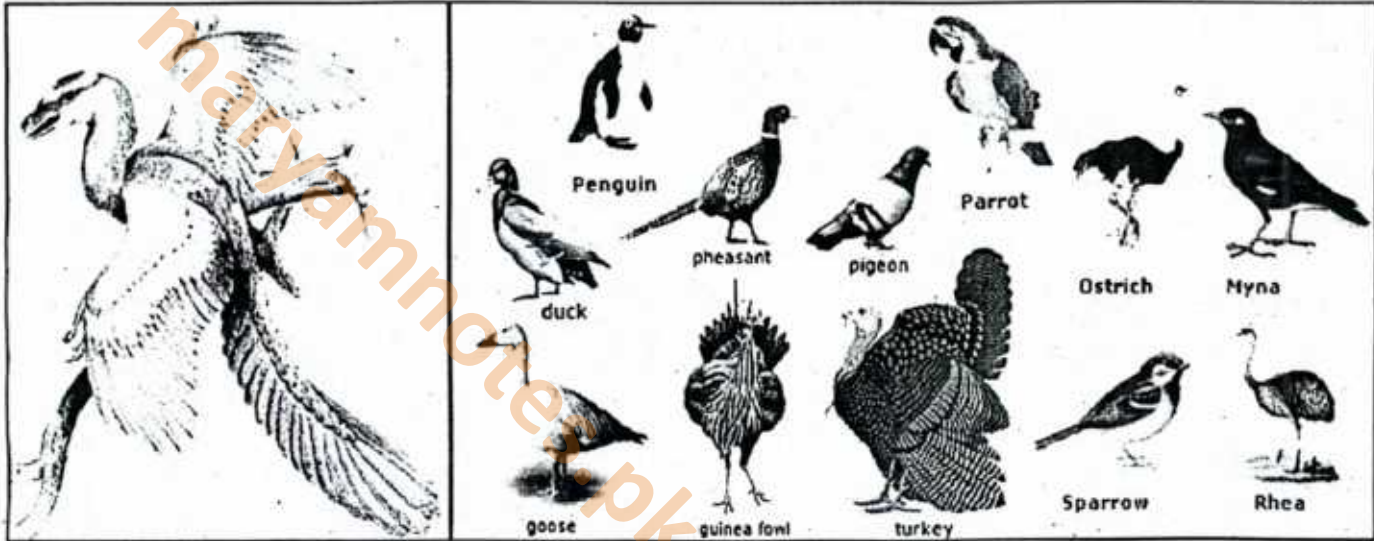
CLASS AVES (Birds)

- | | |
|---|--|
| 1. Their body is stream-lined and spindle shaped. | 2. Birds are warm blooded or homeothermic. |
| 3. There is epidermal exoskeleton of feathers. | 4. Legs are covered by scales. |
| 5. Air spaces are present in the bones. | 6. Heart has four chambers. |
| 7. The lungs have air sacs. | 8. The organ of voice is called syrinx. |

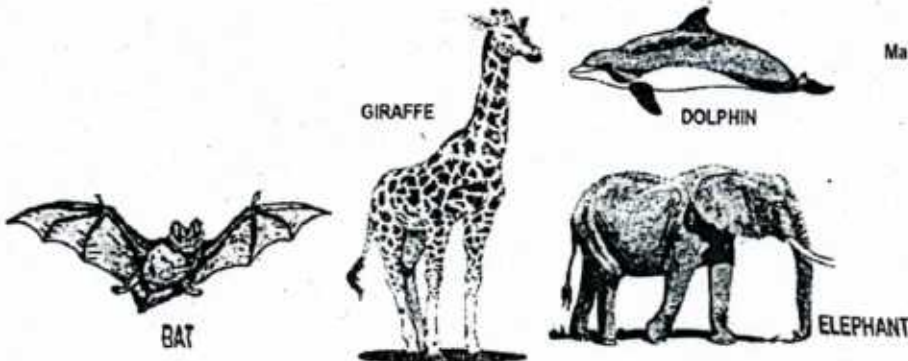
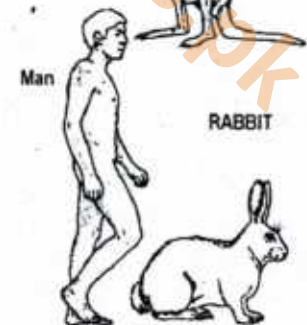
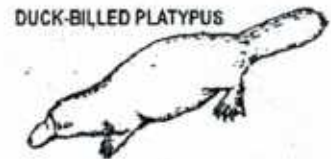
9. Jaws extend to form horny beak. Teeth are absent
10. Gizzard is used for crushing of food.
11. Limbs are adapted for flying. The fore-limbs are modified into wings.

Examples:

1. **Ratitae** are flightless birds: For example; Ostrich, Kiwi, Hen, Emu, Cassowary etc.
2. **Carinatae** are flying birds: For example; Parrot, Duck, Sparrow, Crow, Eagles, Pigeon etc.

**CLASS MAMMALIA**

1. The body of the mammals is covered by hairs.
2. There is a muscular diaphragm present between chest and abdomen.
3. The lower jaw has only one large bone.
4. External ear or pinna is present.
5. Mammals have 4 chambered heart.
6. The red blood cells are non-nucleated.
7. Mammals are warm blooded or Homoeothermic.
8. Mammals have well developed voice apparatus called larynx.
9. Most mammals give birth to young.
10. Mammals feed their young on milk. Milk is produced by mammary glands of mother.



Classification:

Mammals are classified into three sub-classes:

1. Prototheria:

These are egg laying mammals:

Examples

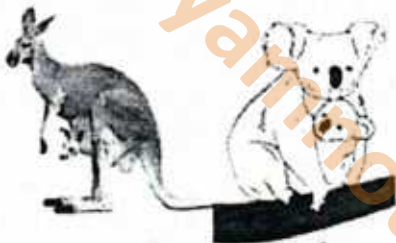
Duck bill Platypus, Echidna

**2. Metatheria:**

These are pouched/marsupial Mammals.

Examples

Kangaroo, Tasmanian wolf etc.

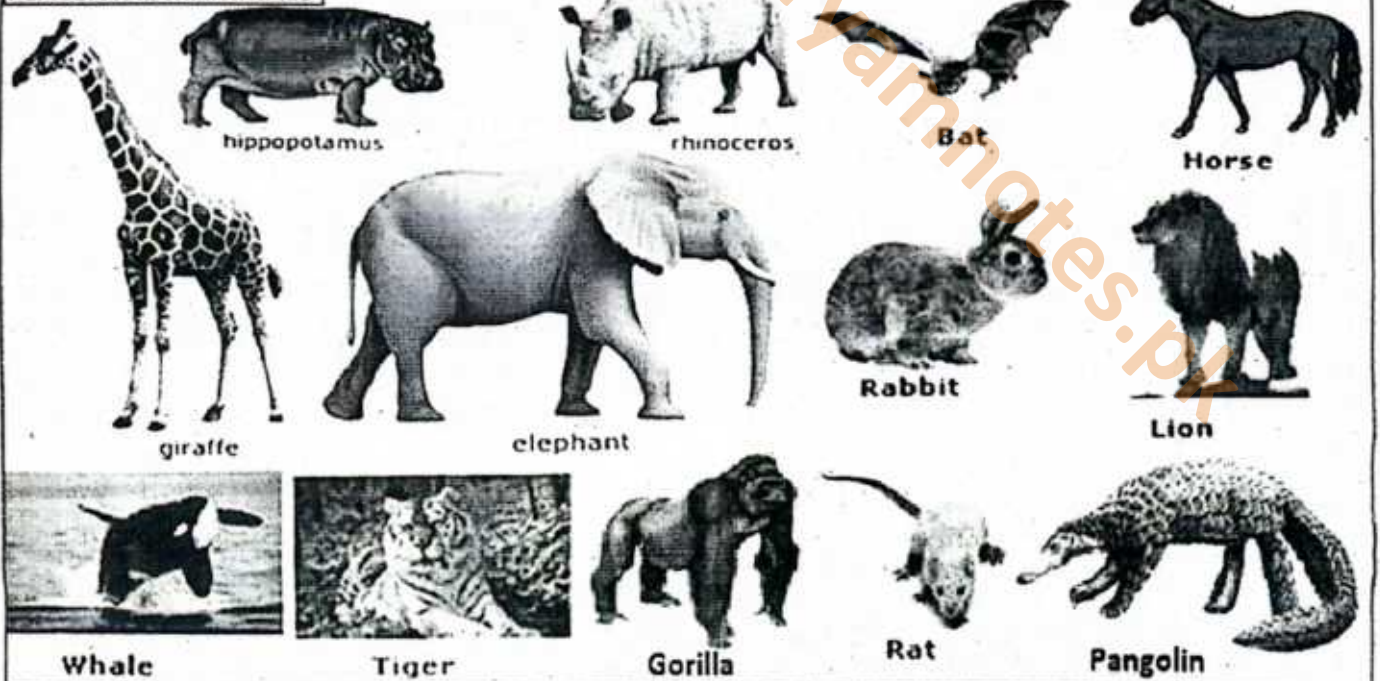
**MARSUPIAL MAMMALS**

Koala

**3. Eutheria:**

These are placental mammals including man. It has following orders:

- | | | | |
|--------------------|--------------------------|------------------|-------------------------|
| a) Rodentia: | Rats, squirrel | b) Artiodactyla: | Deer, Sheep, Cow |
| c) Perissodactyla: | Zebra, Horse, Donkey | d) Insectivora: | Hedge hog, Shrew, Moles |
| e) Carnivora: | Lion, Cat, Cheetah, Dogs | f) Chiroptera: | Bat |
| g) Cetaceae: | Whales, Dolphins | h) Proboscida: | Elephant |
| i) Edentata: | Scaly anteater | j) Primates: | Man, Monkey, Apes |

PLACENTAL MAMMALS

2. VERTEBRAL COLUMN PRESENT (VERTEBRATE)

BILATERAL SYMMETRICAL

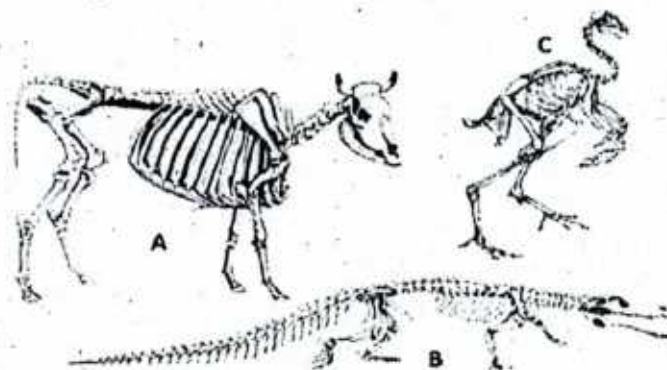
Super class Pisces (Body without limbs, fish like and Aquatic)				Super class Tetrapoda (Body with 4 limbs)			
Agnatha (Jawless Fishes)	Gnathostomata (Jawed fishes)		Amphibia (dual life, slippery body, no distinct neck scales and scales)	Reptilia (creepers, with distinct neck scales on body)	Aves (Feathers)	Mammals (Mammary glands, Hairy skin)	
	Class Cyclostomata (Lampreys)	Class Chondrichthyes (Cartilaginous fishes)					Class Ostichthyes (Bony fishes)
1. No jaws	1. jaws Present	1. jaws Present	1. slippery body	1. Usually rough body	1. Feathers on the body	1. Hair on skin	
2. Eel like body	2. Stream lined, fish like body	2. Stream lined, fish like body	2. No distinct neck	2. Distinct Neck	2. Distinct Neck	2. Mammary glands found	
3. 5 to 16 gill pairs pore like openings	3. 5 to 7 gill pairs vertical openings	3. 4 gill pairs vertical openings	3. No distinct scales	3. Distinct scales or carapace	3. Distinct scales	3. Outer ear present	
4. No operculum on gills	4. No operculum on gills	4. Operculum on gills	4. May have tail (Salamanders and Newts)	4. All have tails	4. beak	4. give birth to young one	
5. fibrous- cartilaginous skeleton	5. Cartilaginous skeleton	5. Bony skeleton	5. If No tail (Frogs and toads)	5. Without limbs (snakes)	5. Keel found (Boat like body)	5. Cloaca may present, egg laying (Subclass prototheria)	
6. Toothed tongue	6. Toothed tongue	6. Swimbladder present		6. with limbs (lizards, tortoises & turtles, crocodiles)		6. Pouch/marsupium found (Subclass metatheria)	
7. Mouth ventral and sucker like	7. Mouth ventral	7. Mouth terminal				7. placenta and separate urogenital openings present (Subclass Eutheria)	
8. Round caudal fin.	8. heterocercal caudal fin	8. homocercal caudal fin					
EXAMPLES: 1. Lampreys 2. Hag fishes	EXAMPLES: 1. Sharks 2. Sting rays 3. Electric ray	EXAMPLES: 1. Rohu 2. Salmon 3. Trout 4. Sea horse	EXAMPLES: 1. Salamanders and Newts (Tailed) 2. Frogs and toads (Without tail)	EXAMPLES: 1. snakes 2. lizards, tortoises and turtles, crocodiles	EXAMPLES: 1. Running birds: Hen, ostrich, Emu, turkey 2. Flying birds: Eagle, sparrow, crow, pigeon, parrot etc.	EXAMPLES: 1. Duckbill platypus, Echidna 2. kangaroo, opposum teddy bear 3. Man, cats, dogs, lions, cows etc.	

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Given below are the diagrams of animals belonging to 3 vertebrate Groups:

(i) To which class these animals belong? (2)

Ans: _____



(ii) Give 3 major characters that are common in A, B and C. (1)

Ans: _____

(iii) Enlist 2 clear characters that distinguish B from C.

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i) A. Class Mammalia B. Class Reptilia C. Class Aves (Birds)

(ii) Notochord (Vertebral column), Hollow dorsal nervous system, Post-anal tail.

(iii) Toothless Beak (C) / Teeth with Jaws (B); Feathers (C) / Scaly skin (B).

EXPERIMENT

18

TO OBSERVE AND IDENTIFY THE CHARACTERISTICS OF REPRESENTATIVE MAJOR EXAMPLES OF KINGDOM PROTISTA (PROTOZOA, ALGAE, MYXOMYCOTA AND OOMYCOTA) THROUGH PRESERVED SPECIMENS OR PREPARED SLIDE.

APPARATUS:

- Compound microscope
- Prepared slides, specimens and fresh materials (if provided) of chlorella, Paramecium, Amoeba, Entamoeba, Plasmodium, Euglena, Ulothrix and ulva.

PROCEDURE

Take one drop of fresh material on slide and study at low and high powers under microscope.

1. THE ALGAE : PLANT LIKE PROTISTS

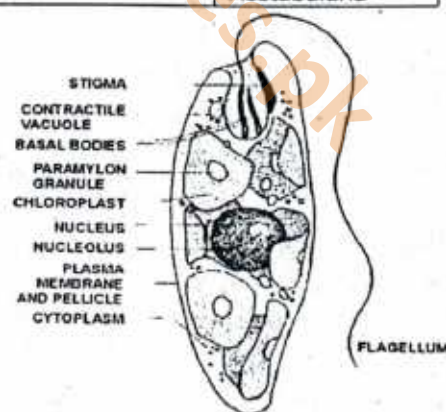
Phylum	Common name	Form	Locomotion	Pigments	Examples
Euglenophyta	Euglenoids	Unicellular	2 flagella one long one short	Chl.a, Chl.b Carotenoids	Euglena
Pyrrophyta	Dinoflagellates	Unicellular	Two flagella	Chl.a, Chl.c Carotenes including Fucoxanthin	Gonyaulax, Ceratum
Chrysophyta	Diatoms	Usually unicellular	Usually none	Chl.a, Chl.c Carotenes including Fucoxanthin	Diatoma, Frequilaria Pinnularia
Phaeophyta	Brown algae	Multicellular	2 flagella on reproductive cell	Chl.a, Chl.c Carotenes including Fucoxanthin	Fucus, Macrocystis
Rhodophyta	Red algae	Multicellular Or unicellular	None	Chl.a carotenes Phycoerythrin	Chondrus Polysiphonia
Chlorophyta	Green algae	Unicellular, colonial, multicellular	Most have flagella	Chl.a, Chl.b, Carotenes	Chlorella, Ulva, Spirogyra Acetabularia

EUGLENA**Observations**

- Unicellular
- Two flagella. One long other short.
- Chlorophylls present
- Lack cell wall
- Contractile vacuoles present

Reason for identification:

- Spindle shaped body with flagella.

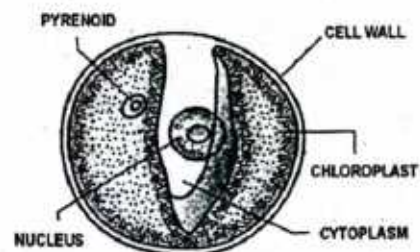


CHLORELLA**Observations**

- Unicellular alga.
- Spherical
- Cup shaped chloroplast
- Single nucleus
- Pyrenoid in chloroplast.
- Used for research on photosynthesis
- Future alternate source of food.

Reason for identification:

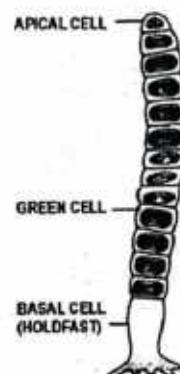
- Cup shaped chloroplast is present with pyrenoid.

**ULOTHRIX****Observations**

- Filamentous algae.
- Filament is attached by holdfast.
- Chloroplast is girdle shaped.
- Thin layer of cytoplasm
- One or more pyrenoids may be present in chlorophylls.

Reason for identification:

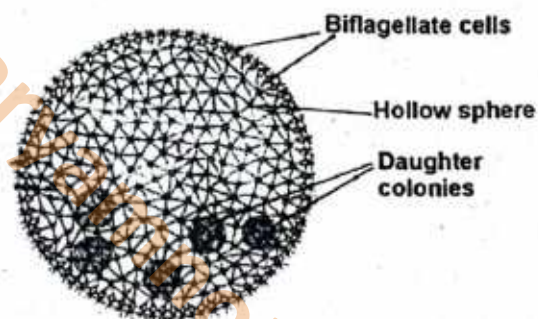
- Filamentous body with girdle shaped chloroplast
- Attachment by hold fast

**VOLVOX****Observations**

- Colonial algae
- Colony is covered by mucilaginous sheath
- Colony moves by flagella.
- Individual cells are oval or spherical in shape.
- Sexual reproduction takes place by oogamy.

Reason for identification:

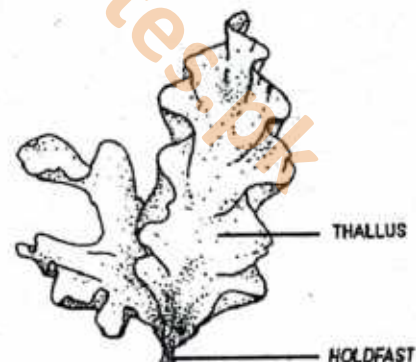
- Rounded colony containing daughter colonies.
- Pin head size, green ball like structure

**ULVA****Observations**

- Body is thallus (also called Sea lettuce).
- Sheet like multicellular body.
- Attached with substratum by holdfast.
- Asexual reproduction takes place by zoospore formation.
- Sexual reproduction by isogamy (Isomorphic AOG).

Reason for identification:

- Sheet like body
- Bright green chloroplast is present



2. PROTOZOA: ANIMAL LIKE PROTISTS

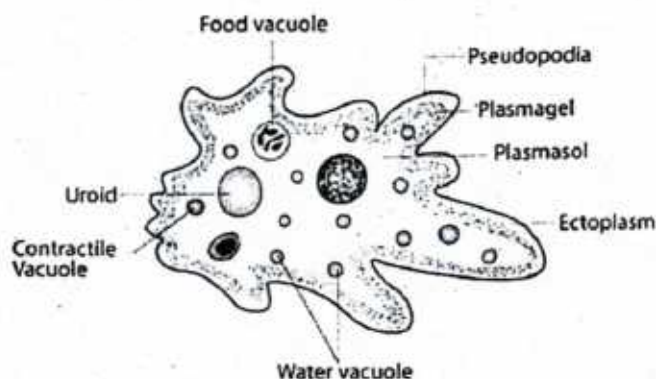
COMMON NAME	FORM	LOCOMOTION	EXAMPLES
Amoebas	Unicellular, no definite shape	Pseudopods	Amoeba, Entamoeba
Zooflagellates	Unicellular, some colonial	One or more flagella	Trypanosoma, Euglena
Actinopods	Unicellular	Pseudopods	Radiolarians
Foraminifera	Unicellular	Pseudopods	Forams
Apicomplexans	Unicellular	None	Plasmodium
Ciliates	Unicellular	Cilia	Paramecium, Vorticella, Stentor

AMOEBA

- Unicellular
- Contractile vacuole present.
- Always changes its shape
- Moves by pseudopodia
- Reproduce asexually by binary fission and spore formation

Reason for identification:

- Irregular shape
- Presence of pseudopodia

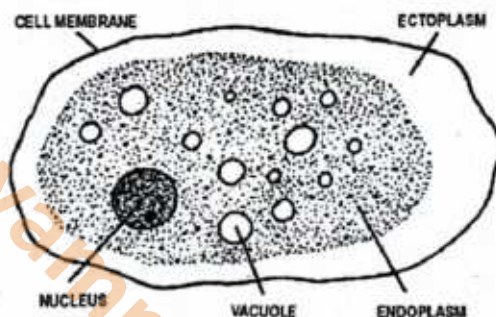


ENTAMOEBA

- Unicellular
- Human parasite
- Causes amoebic dysentery in man
- Moves by pseudopodia
- Reproduce asexually by binary fission & spore formation

Reason for identification:

- Presence of blood cells in its body
- A bit round and possess pseudopodia

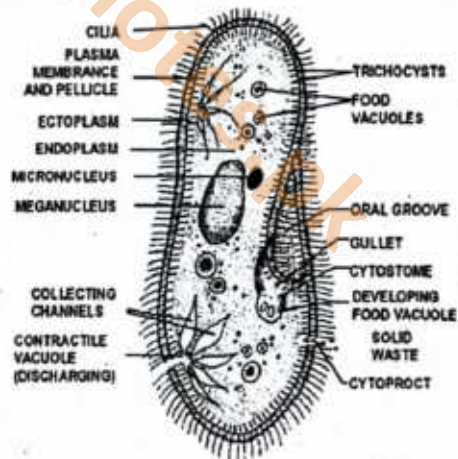


PARAMECIUM

- Unicellular organism
- Body is covered by cilia
- Outer covering is called pellicle
- Contractile vacuole is present
- It has two nuclei: micronucleus and macronucleus.
- Sexual reproduction takes place by conjugation.

Reason for identification:

- Shoe shape
- Cilia all around the body
- Presence of 2 nuclei

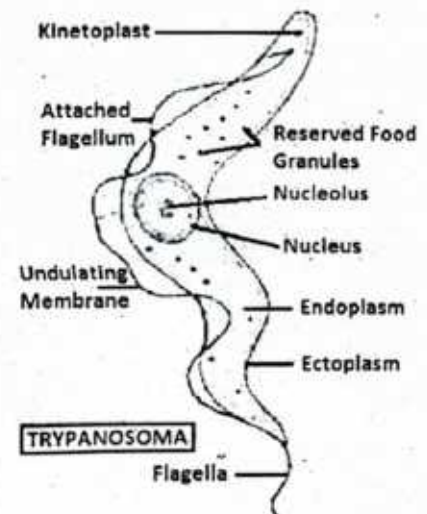


TRYPANOSOMA**Observations**

- Unicellular (varies in length from 10 μm to 40 μm).
- Blood parasite
- Flagella are found
- Spindle shaped body
- Trypanosoma has a single undulating membrane that ends in an anterior flagellum.
- The parasite is composed of a kinetoplast, which is an organelle that contains circular DNA molecules and mitochondria.

Reason for identification:

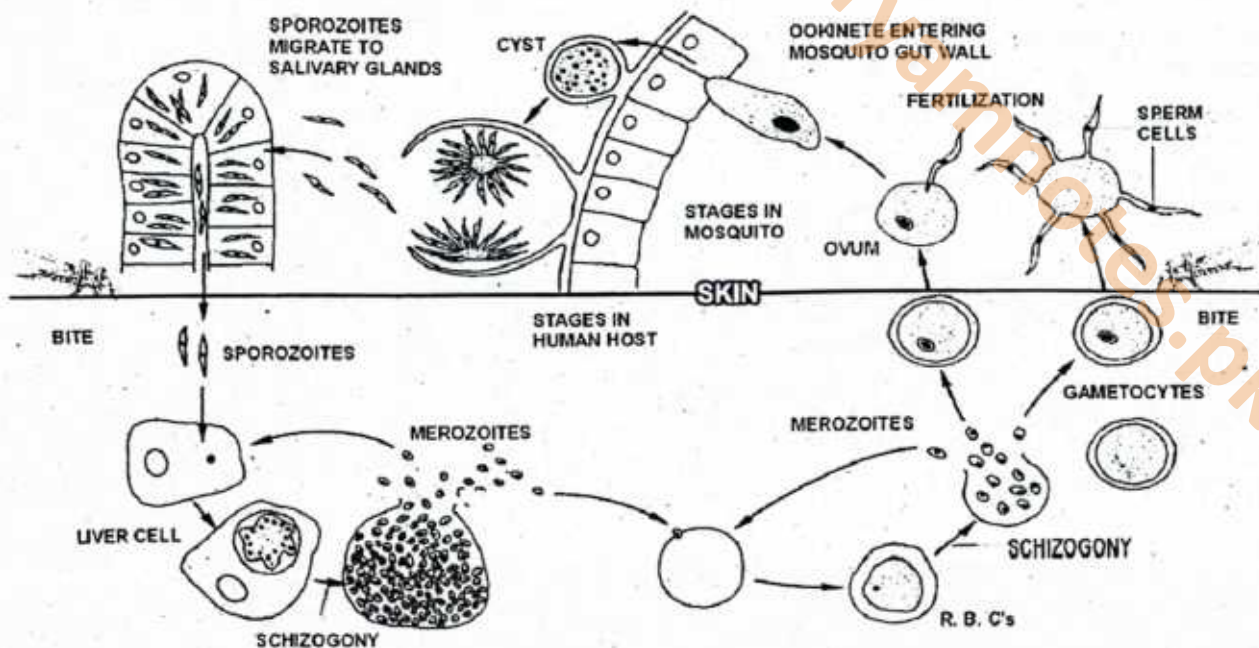
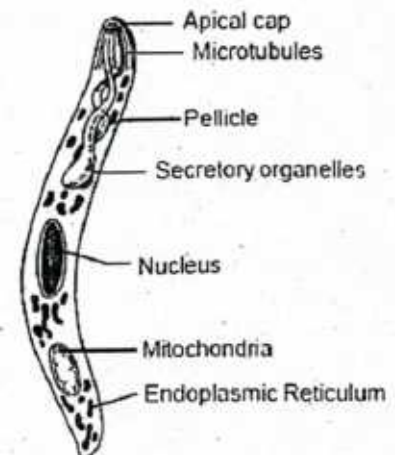
- Spindle shaped body
- Single undulating membrane that ends in an anterior flagellum

**PLASMODIUM****Observations**

- Unicellular
- Develops spore sexually in mosquito at some stage of their life (sporozoites)
- No locomotory organs
- Reproduces in man asexually (merozoites)
- Spends its life in two host: man and mosquito
- Causes malaria in man.

Reason for identification:

- Spindle shaped body
- Dark tiny dots in blood.

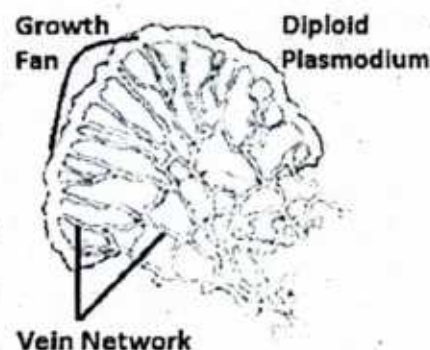


3. FUNGI LIKE PROTISTS

Phylum	Form	Locomotion	Body Form	Examples
Slime Molds OR Myxomycota	Multicellular	Amoeboid 2-4 flagella	Plasmodium	Physarum polycephalum
Water Molds OR Oomycota	Multicellular	Two flagella	Hyphae	Phytophthora infestans

PHYSARUM POLYCEPHALUM**Observations**

- The feeding stage of a slime mold is a plasmodium.
- It is a multinucleate mass of cytoplasm that can grow to 30 cm (1ft) in diameter.
- It is slimy in appearance
- It streams over damp, decaying logs and leaf litter.
- It often forms a network of channels that covers a large surface area.
- During creeping it ingests bacteria, yeasts & spores decaying organic matter.

**Reason for identification:**

- The cells are multinucleate (coenocytic), forming a thin film called a plasmodium

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

- 1) How does Chlorella reproduce?**
Ans: The only method of reproduction in Chlorella is by means of autospores (aplanospores) i.e. same shape like parents
- 2) What is the shape of the chloroplast of chlorella?**
Ans: It is cup shaped or curved.
- 3) What is the normal shape of Euglena? Name its kingdom.**
Ans: Euglena is normally spindle-shaped. Its kingdom is Protista (Protoctista).
- 4) What is pellicle in Euglena? What is its other name?**
Ans: Pellicle is outer thin flexible membrane around the body of Euglena. It is also called plasma membrane.
- 5) What is the habitat of Volvox?**
Ans: It is fresh water ponds, pools and ditches rich in ammonium salts.
- 6) What is the origin of the name Volvox?**
Ans: The name Volvox has been derived from a latin word volvere which means "to roll".
- 7) Name a marine species of Ulothrix.**
Ans: It is Ulothrix flacca which is found in the tide pools.
- 8) What is the shape of the thallus of Ulothrix?**
Ans: It is filamentous.
- 9) What is Ulva commonly known as?**
Ans: Ulva is commonly known as the "Sea lettuce".
- 10) Where does Ulva live?**
Ans: Ulva lives in the tide pools along the sea coast.
- 11) How do the pseudopodia of Amoeba and Entamoeba histolytica differ?**
Ans: The pseudopodia of Amoeba consist of both the ectoplasm as well as the endoplasm whereas those of Entamoeba consist of only the ectoplasm.
- 12) In which protozoans are found contractile vacuoles?**
Ans: The contractile vacuoles are found in those protozoans which live in fresh water.

13) What is the general shape of Paramecium? What is its nature?

Ans: The Paramecium is elongated and cylindrical or slipper like in shape. It is a ciliated protozoan.

14) How does a Paramecium move? Where does it live?

Ans: The paramecium moves by means of cilia. It lives in freshwater ponds and streams.

15) What is an "alternation of hosts" (regarding plasmodium)?

Ans: When a parasite needs two hosts for the completion of its life-history and the hosts alternate with each-other, it is called alternation of hosts as in the life cycle of malarial parasite.

16) To which kingdom and the group of protozoans does plasmodium belong?

Ans: The Plasmodium belongs to kingdom Protista and the group Apicomplexan of protozoans.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

(i) Draw a labelled diagram of amoeba.

(2)

(ii) Name one colonial protist?

(1)

Ans: _____

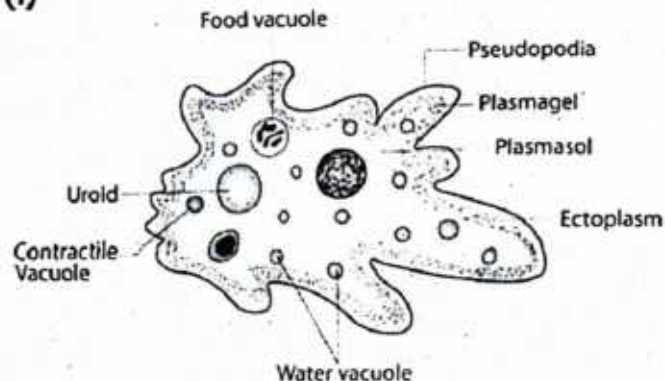
(iii) Give 2 examples of animal like protists.

(1)

Ans: _____

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)

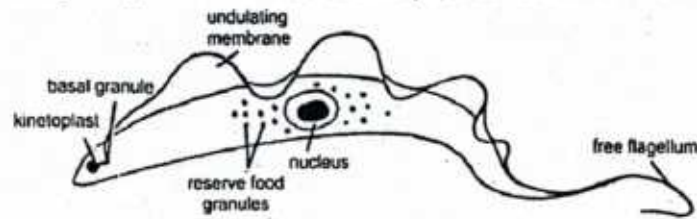


(ii) volvox

(iii) Euglena, amoeba, paramecium.

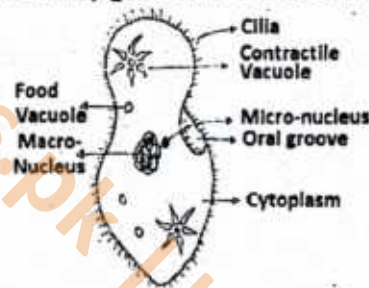
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

(i) Identify the Given diagram; Which disease this protist causes in human: (1)



Ans: _____

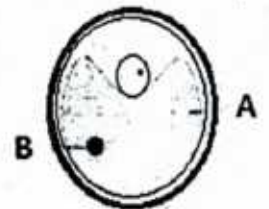
(ii) Given in the diagram is paramecium; give one function of micronucleus and macronucleus (1)



Ans: _____

(iii) Chlorella is shown in the figure; Label its part A and B. Give function of B: (2)

Ans: _____

**Solution: Practical Based Assessment (PBA) Sample Paper- 2**

- (i) Trypanosomiasis (Sleeping sickness)
 (ii) Micronucleus is involved in reproduction.
 Macronucleus controls metabolism and other functions.
 (iii) A. Chloroplast
 B. Pyrenoid
 Function of B: Site of starch grains formation and storage.

EXPERIMENT

19

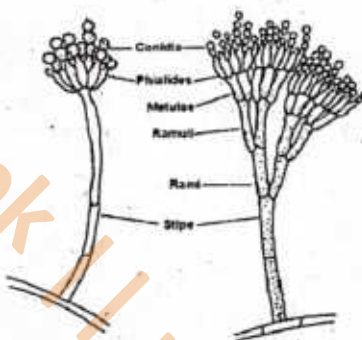
TO OBSERVE AND IDENTIFY THE CHARACTERISTICS OF REPRESENTATIVE EXAMPLES FROM DIFFERENT DIVISIONS OF KINGDOM FUNGI (ZYGOMYCOTA, ASCOMYCOTA, DEUTEROMYCOTA AND BASIDIOMYCOTA) THROUGH PRESERVED SPECIMENS OR PREPARED SLIDE OR DIAGRAMS.

APPARATUS:

- Microscope
- Glass slides
- Cover slips.
- Penicillium, Rhizopus growth on bread
- Prepared slides of Hyphae
- Glycerine water solution (1:1)

PROCEDURE

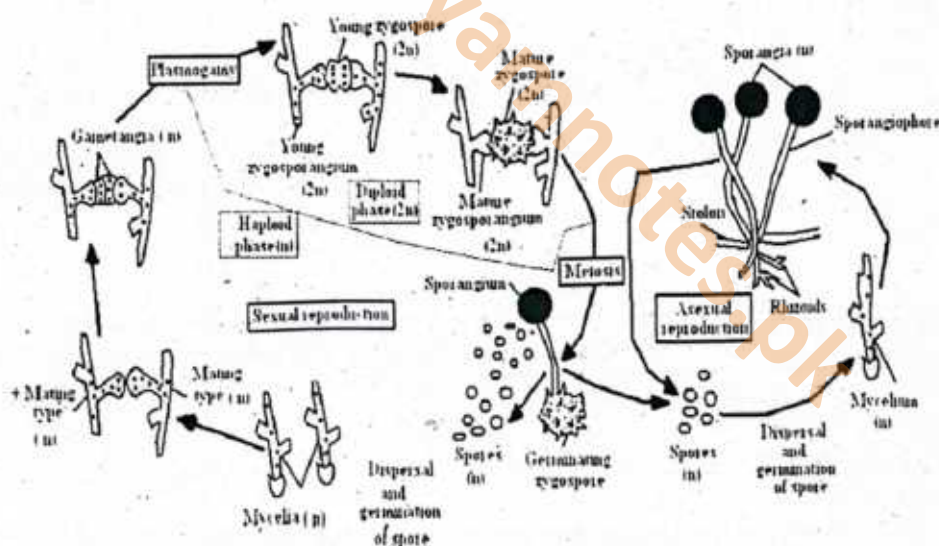
- Pick up the infected sample with the needle on a glass slide.
- Put a drop of glycerine on slide and cover it with the help of cover slip.
- Examine it under medium and high resolution of microscope.
- Now place prepared slides under microscope and note down the observations.

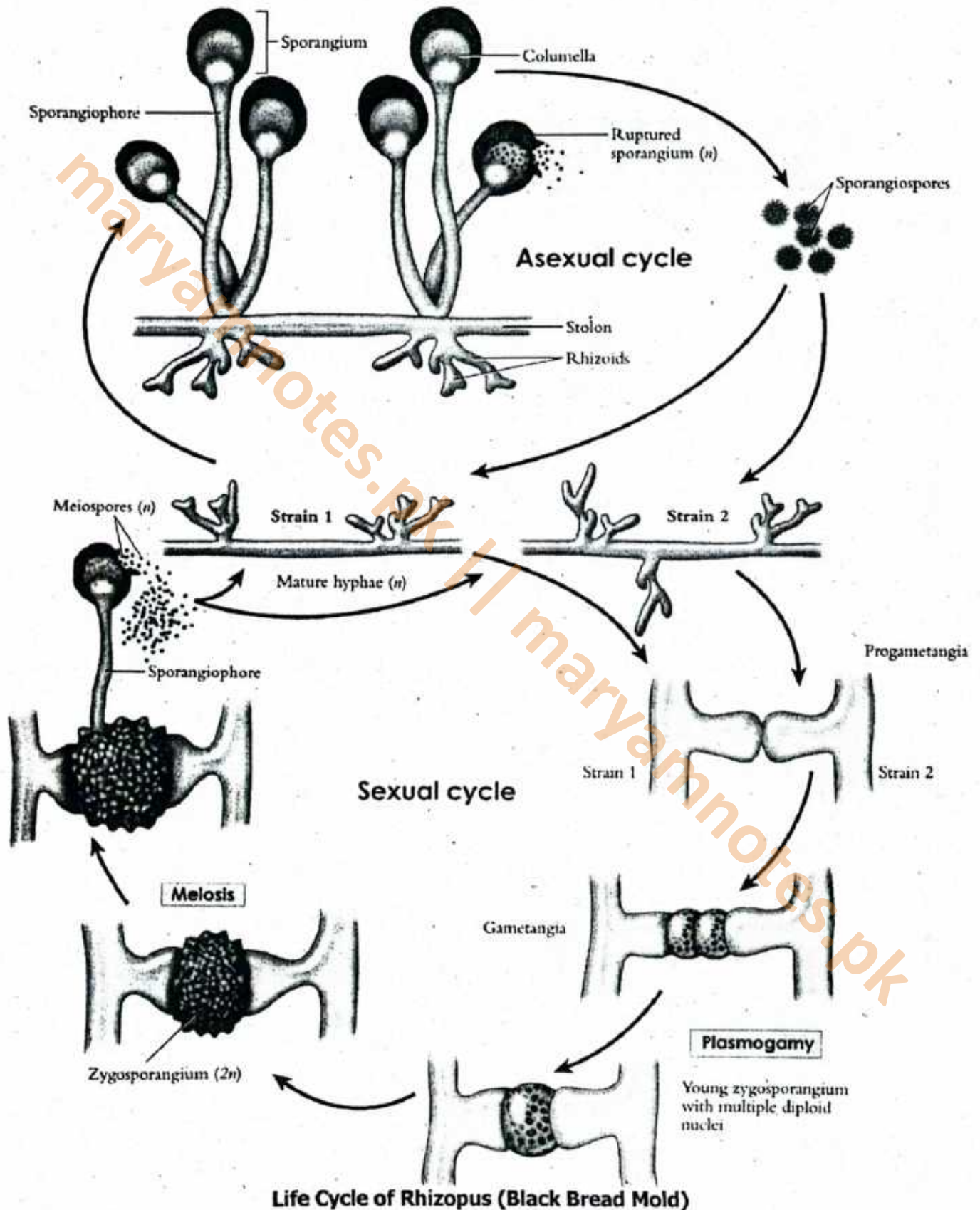
**Observations of Penicillium:**

- Septate Hyphae are seen giving broom like appearance.
- Conidiophores are seen.
- Conidia are seen.

Observations of Rhizopus:

- Columella is present and it is dome-shaped.
- Mature sporangia are black in colour.
- Immature sporangia are white in colour.
- At maturation stage, tip of sporangiophore swells.
- There are many nuclei present in each sporangium.
- Many spores are present in each sporangium.



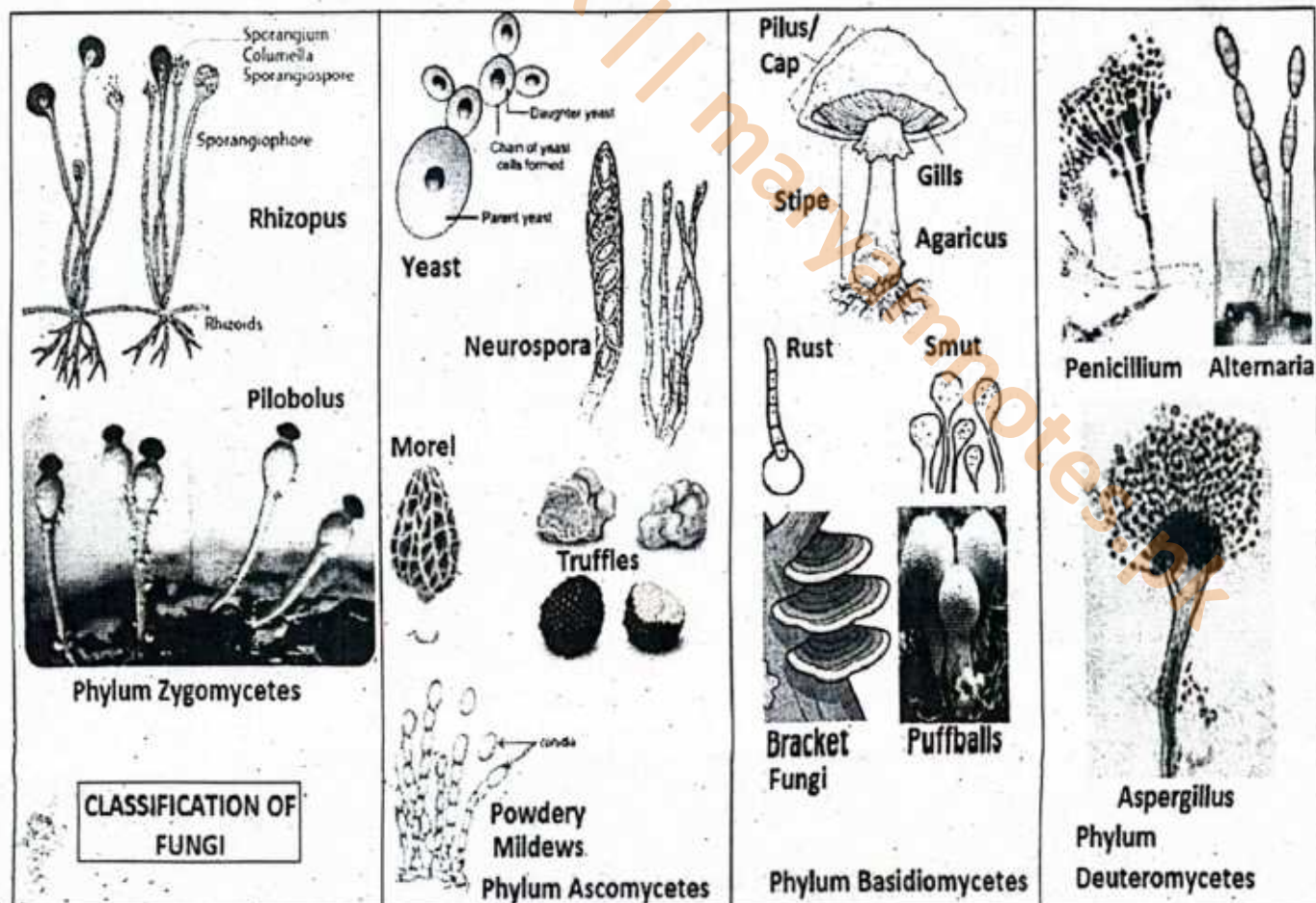


Classification of Kingdom fungi

Classification of fungi into four main groups is based primarily on the **type of their sexual reproductive structures** and **methods of reproduction**.

However, these groups also differ in the **type of hyphae** and some other characters

Phylum (group)	Zygomycota (Zygomycetes or Cojugating Fungi)	Ascomycota (Ascomycetes or Sac fungi)	Basidiomycota (Basidiomycetes or club fungi)	Deuteromycota (Deuteromycetes / Imperfect fungi)
HYPHAE	Non septate multi nucleate	Septate, lengthy dikaryotic phase	Septate, lengthy dikaryotic phase	Varied (Mostly septate)
ASEXUAL REPRODUCTION	Non Motile spores form in sporangia	Conidia cut off from tips of conidiophores, budding	Uncommon	Conidia
SEXUAL REPRODUCTION	Zygospores	Ascospores inside sac like asci	Basidiospores borne on club shaped basidia	Sexual phase has not been observed
EXAMPLES	Rhizopus (Black bread mold) Pilobolus (spitting fungus)	Yeasts, morels, truffles, powdery mildews, molds, Neurospora etc.	Mushrooms, rusts, smuts, puff balls, bracket fungi	Aspergillus, Penicillium, Alternaria etc.



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1) What is the common name for rhizopus?

Ans: Rhizopus is a genus of fungi. It is commonly called bread mould

2) Why rhizopus is called Bread Mould?

Ans: Rhizopus species generally grow on bread, hence, the name bread mould. Rhizopus stolonifer is specifically called black bread mould as it is a black mould that grows on bread.

3) Where is rhizopus found?

Ans: Rhizopus is a genus of saprophytic fungi which commonly grows on jellies, syrups, leather, bread, etc. They are also found as parasites in animals causing fungal infection, e.g. zygomycosis in humans

4) Which class does Rhizopus belong to?

Ans: Yes, Rhizopus reproduce asexually as well as sexually. Asexual reproduction is by the formation of sporangiospores and chlamydospores. Sexual reproduction is by fusion of two compatible hyphae. They can either be heterothallic, i.e. having different mycelium for + and - mating strains or homothallic.

5) Give the phylum and class of Rhizopus.

Ans: Rhizopus belongs to the class Zygomycetes of the phylum Zygomycota.

6) What is unique about Penicillium?

Ans: Penicillium is an important genus of phylum ascomycota, found in the natural environment as well as in food and drug production. Some members of the genus produce penicillin, a molecule used as an antibiotic that kills or stops the growth of certain kinds of bacteria

7) What causes Penicillium to grow?

Ans: Habitat/Écology. Penicillium are very commonly found in soil, on decaying vegetation and compost or on wood, dried foodstuffs, spices, dry cereals, fresh fruit and vegetables. They are also found growing on building materials in water-damaged environments as well as in indoor air and house dust.

8) Is Penicillium helpful or harmful?

Ans: Like many molds, Penicillium can threaten those with weak or compromised immune systems, causing allergic reactions or infections. Some species produce mycotoxins which are known carcinogens. Others species cause measurable organ damage when inhaled

9) What is the color of Penicillium?

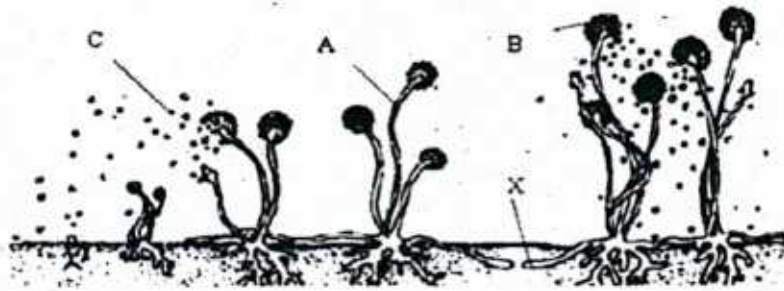
Ans: Penicillium spp. are initially white and become blue-green, gray-green, olive-gray, yellow or pinkish with time. Multicellular fungi are composed of filaments called hyphae. Hyphae may contain internal cross-walls, called septa, that divide the hyphae into separate cells

10) Why is it called Penicillium?

Ans: Because the mold was identified as belonging to the genus Penicillium (Latin for "brush," referring to the chains of conidia that resemble a paintbrush or broom), Fleming named the antibacterial substance penicillin.

11) What is the asexual organ of Penicillium?

Ans: The common asexual reproductive structure in penicillium is conidia. Conidia: They are asexually formed spores that are present outside the cells. Conidial spores are formed on the conidiophores

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

- (i) Name the parts labelled A, B, C and X of diagram given below. (2)

Ans:

- (ii) Give a role, other than anchorage, for the structure X. (2)

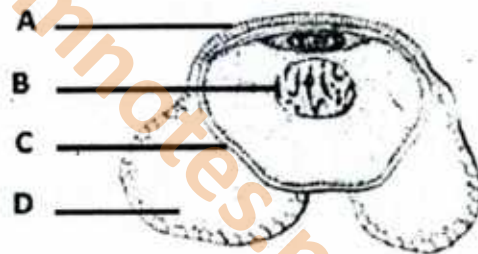
Ans:

Solution: Practical Based Assessment (PBA) Sample Paper- 1

- (i) A. Sporangium B. Sporangium C. Spores X. Rhizoid
(ii) X: it is involved in saprotrophic nutrition (absorptive heterotrophy).

**MODEL SAMPLE PAPER-1
SECTION-B****(12 Marks)****Q.4 (i) Draw a labelled diagram of Conidiophore.****(1)****Ans:****(ii) Which one reproduces sexually as well as asexually? (1)**

- a. Rhizopus b. Penicillium c. Alternaria d. All of these

Ans:**(iii) Give 2 distinguishing features of Penicillium: (1)****Ans:****(iv) Enlist 2 methods of reproduction in Penicillium: (1)****Ans:****Q.5 Given in the diagram is a plant structure:****(i) Label the parts A and C (1)****Ans:****(ii) Identify and Give the functions of the labelled parts B and D: (2)****Ans:****(iii) Identify the whole structure; how these structures propagate: (1)****Ans:**

Q.6 A man with type AB blood is married to a woman with type O blood. They have two natural children and one adopted child. Kiran has type A blood, Raveeha has type B blood, and Hamna has type O blood.

i) Which child was adopted and why? (2)

Ans: _____

ii) Can Kiran and Raveeha have allele O? (1)

Ans: _____

iii) Which individual in this whole scenario cannot be homozygous? (1)

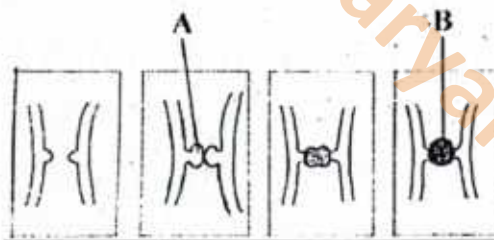
Ans: _____

MODEL SAMPLE PAPER-2

SECTION-B

(12 Marks)

Q.4 Fungi are living things that lack chlorophyll, are parasitic or live on dead or decaying organic matter, and were formerly considered plants: Identify the diagram given below:



(i) Diagrams show stages of sexual reproduction of *Rhizopus*. Name the parts labeled A and B. (1)

(ii) What is the function of B? (1)

(iii) What is the correct sequence of sexual reproduction in *Rhizopus*? (1)

(iv) How conjugation occurs in rhizopus? (1)

Q.5 Vertebrates are a large group animals which are distinguished by the possession of a backbone or spinal column. Identify the animals shown in the figure:



(i) Enlist 2 characters that are common in A and B: (2)

(ii) Identify the Animals A and B: (1)

(iii) Name the classes of animals in figure A and B: (1)

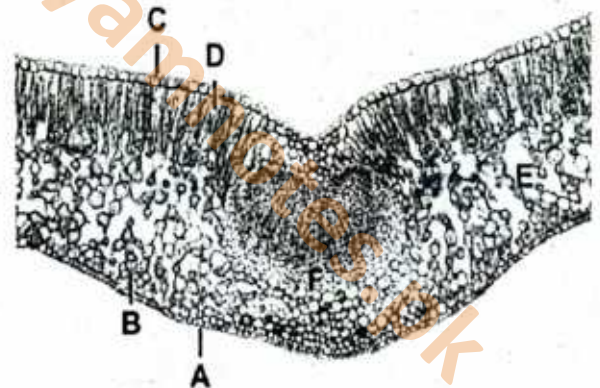
Q.6 Identify the given diagram:

(a) Label the parts B & D; also give their role: (2)

Ans: _____

(b) Define bifacial leaf; give examples: (2)

Ans: _____



Solution:**MODEL SAMPLE PAPER- 1****SECTION-B**

- Q.4** (i) See the diagram in text.
 (ii) a
 (iii) *Penicillium* spp. are initially white and become blue-green with time. Multicellular fungi are composed of branched filaments called hyphae. Hyphae are septate.
 (iv) Conidia formation, fragmentation and parasexuality.
- Q.5** (i) **A:** Exine **C:** Intine
 (ii) **B:** **Prothallial cells:-** The two small cells at one side are called prothallial cells. A larger cell, the generative cell, lies next to the prothallial cell. It will eventually produce two sperm cells while a smaller new cell called tube cell that develops into pollen tube.
D: Wings:- The "wings" of *Pinus* pollen are two-sided, bladder-like outgrowths of the exine, the outer layer of the pollen grain.
 (iii) The structure is a pollen of *Pinus*; and these pollen propagate through wings (Anemophilous).
- Q.6** (i) Hamna is an adopted child as it has O blood group. So Hamna can only inherit One O allele from his mother but his father cannot contribute O allele. While in case of Kiran and Raveeha Allele A and B are inherited by Father respectively and Mother donated O allele to both of them leading to their heterozygous blood groups AO and BO respectively.
 (ii) Yes. As Both Kiran and Raveeha have blood group A and B; in heterozygous state both have allele O i.e, $I^A I^O$, $I^B I^O$
 (iii) As Father has blood group AB, so only he can never have any homozygosity.

Phenotypes and Genotypes of the parents and children are given below:

	Phenotypes	Genotypes
Father	AB	$I^A I^B$
Mother	O	$I^O I^O$
Kiran	A	$I^A I^A$ or $I^A I^O$
Raveeha	B	$I^B I^B$ or $I^B I^O$
Hamna	O	$I^O I^O$

Solution:**MODAL SAMPLE PAPER- 2****SECTION-B**

- Q.4** (i) A. Gametangium B. Zygosporangium
 (ii) Involved in germination of hyphae and produce spores.
 (iii) Sexual reproduction in fungus happens in the following sequence plasmogamy, karyogamy, and meiosis.
 (iv) In *Rhizopus*, sexual reproduction takes place by the copulation of two multinucleate gametangia, that are mainly similar in structure. In sexual reproduction, a dark zygosporangium is produced at the point, where two compatible mycelia fuse.
- Q.5** (i) Both are vertebrates and feed their young ones with milk.
 (ii) **A:** Whale **B:** Bat
 (iii) Both of the animals belong to class Mammalia.
- Q.6** (a) **B:** Spongy parenchyma/mesophyll tissues:
D: Palisade parenchyma/mesophyll tissues:
 Both these mesophyll tissues are involved in photosynthesis.
 (b) A leaf with distinct upper and lower surfaces that are structurally and functionally different. Any dicot Leaf like *Brassica campestris*, Gram, peanut, pea etc.



MODEL BIOLOGY PBA PAPER (COMPOSITE HSSC)

For HSSC Annual Examination 2026 & onwards

Biology Curriculum (2022-23)-Scheme of Studies 2006

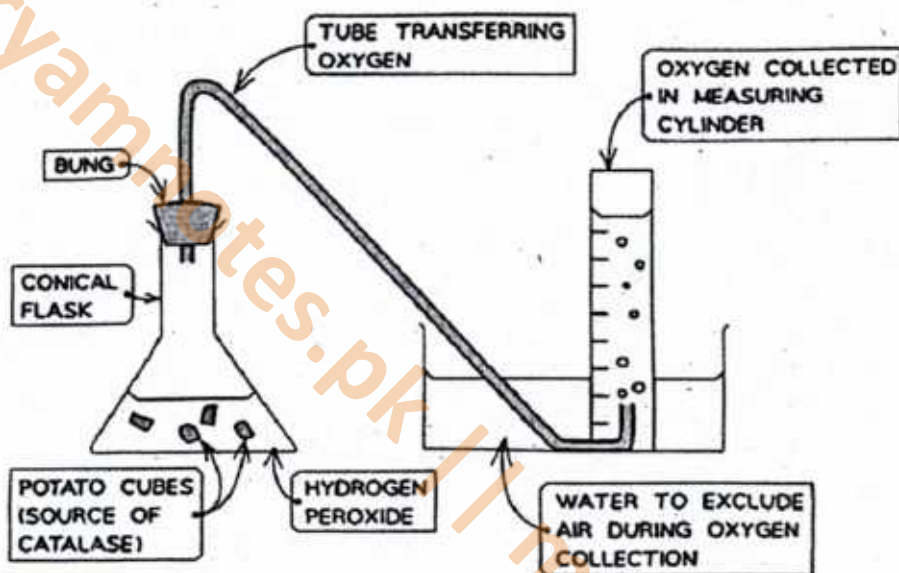
Total Marks: 30

Time: 2:30 hours

Note: Attempt all questions and write within provided spaces on E-sheet.

SECTION-A (18 Marks)

Q.1. Figure 1.1 shows the setup of an experiment in which activity of catalase enzyme is being studied.



- If the effect of substrate concentration is to be investigated, what would be the independent variable and dependent variable in this activity? [2]
- If the conditions for the above experiment are kept constant and the amount of oxygen collected in the cylinder is 10ml at 5 minutes. Predict the amount of oxygen at 15 minutes: [1]
- In the above experiment 1 molar solution of hydrogen peroxide is taken in the flask, how the solution of this concentration is prepared. Show your calculation: [2]
- Which apparatus can be used to maintain the temperature in the above experiment: [1]

Q.2 The antibiotic sensitivity test, also known as the Kirby-Bauer test, is a widely used laboratory method for determining the effectiveness of antibiotics against specific bacterial strains. Table 2.1 below presents the diameters of the zones of inhibition for

antibiotics A, B, C, D, and E, measured across five replicates (R_1 , R_2 , R_3 , R_4 , and R_5). One column displays the diameters of the zones of inhibition from control experiments, where only a filter paper disc of the same size, without any antibiotic, was applied. The diameter of antibiotic disc was 2.5 mm.

Table 2.1: Diameters of Zones of inhibition in millimeters

Replicates	A	B	C	D	E	Control
R_1	6.0	10.0	2.5	12.5	4.5	2.5
R_2	7.0	10.1	2.5	11.0	5.0	2.5
R_3	6.5	12.0	2.5	12.5	5.0	2.5
R_4	7.0	10.2	2.5	12.0	4.0	2.5
R_5	6.0	2.5	2.5	12.5	5.0	2.5
Average / Mean	6.5	10.5	2.5	12.1	4.7	2.5

- a) Analyze the data given in table 2.1 and pinpoint the anomalous reading: [1]
 b) Interpret the data given in table 2.1 and conclude the most effective and least effective antibiotics with reason for your interpretation. [2]
 c) What is the purpose of control experiment in this test? [1]
 d) Draw a bar chart of the data presented in table 2.1 and label it. [2]

Q.3 Following is the data of height of 10 students studying in class 12 (same age group):

Student names	Height (cm)
A	180
B	182
C	175
D	171
E	160
F	172
G	170
H	158
I	165
J	168

- a) Calculate the mean value of the data given in table 3.1. Also show your working. [1]
 b) Calculate the standard deviation of the data given in table 3.1. Show your working. [3]
 c) Calculate standard errors, draw a bar chart and show the error bars. [1+1]

SECTION-B (12 Marks)

Q.4.

- a) Figure 4.1 shows a light microscope in which ocular and objective lenses are used to magnify the object. The source of illumination in this microscope is visible light. Observe the figure carefully and select the numbers that label the objective lens and the source of illumination. [1]



Figure: 4.1

- b) Identify A and B in the figure 4.2. [1]
 c) Write any four differences between tissues A and B shown in figures 4.2 [2]

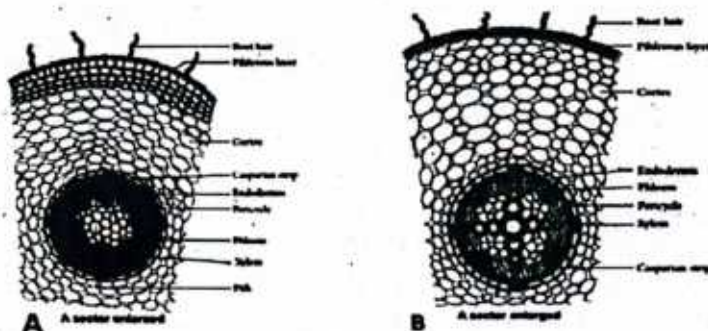


Figure: 4.2

- Q.5** ABO and Rh blood group systems are very significant. These blood groups are always determined before any blood transfusion. Figure 5.1 shows the results of blood group testing of Sikandar's family. Maria is Sikandar's wife while Asad and Hira are their children.

Individuals	Anti-A Antiserum	Anti-B Antiserum	Anti-Rh Antiserum
Sikandar			
Maria			
Asad			
Hira			

Figure 5.1

- a) Identify the blood group of each person. [2]
 b) Draw a genetic cross of Sikandar's family and workout all possible phenotypes and genotypes in their children [2]
- Q.6**
 a) Identify the figure 6.1 and draw its line diagram and label it. [2]

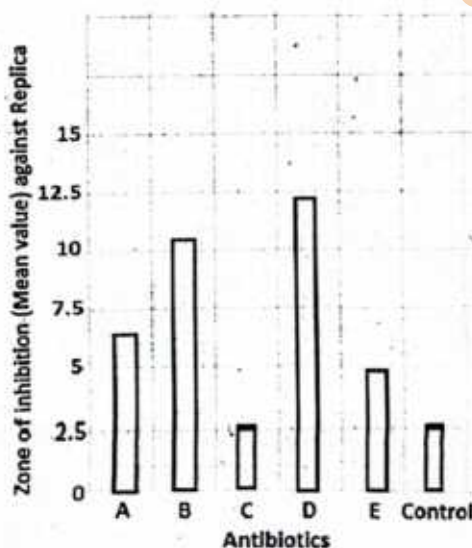


Figure 6.1

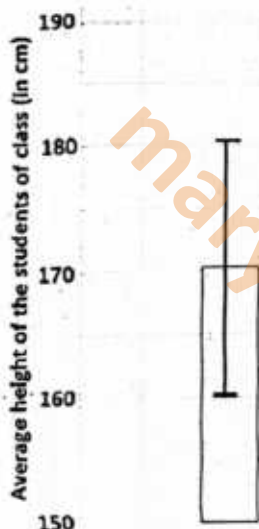
- b) Explain how to prepare temporary slides of plant cells of leaf epidermis to observe under light microscope. [2]

Solution:**FEDERAL BOARD MODEL PAPER**

- Q.1**
- (a) **Independent Variable:** Amount of substrate/Enzyme, pH and Temperature
Dependent Variable: Rate of Enzyme action
- (b) O_2 collected in 5 minutes = 10 ml
 O_2 collected at 15 minutes = 30 ml
- (c)
- Identify Your Stock:** You'll need concentrated H_2O_2 (e.g., 30% w/w or 50% w/w). Note its percentage and find its density (usually on the bottle/SDS).
 - Calculate Stock Molarity (C_1):**
 $C_1 = \text{Density} \times \text{percent purity} \times 10 / \text{Molar mass} = 1.11 \times 30 \times 10 / 34 = 9.76 \text{ M}$
 - Use Dilution Formula ($C_1V_1 = C_2V_2$):**
 C_1 : Stock Molarity (e.g., 9.76 M) V_1 : Volume of stock needed (what you solve for)
 C_2 : Desired Molarity (1 M) V_2 : Desired final volume (e.g., 500 mL, 1 L)
 - Calculate V_1 (Example for 1000 mL of 1M):**
 $9.76 \text{ M} \times V_1 = 1 \text{ M} \times 1000 \text{ mL}$
 $V_1 = 1000 / 9.76 \approx 102.5 \text{ mL}$
 - Dilute Safely:**
 Add 850 mL of distilled/deionized water to a clean volumetric flask or beaker.
 Carefully add the calculated volume (e.g., 102.5 mL) of stock H_2O_2 to the water.
 Add more water to reach the final volume mark (e.g., 1000 mL).
- (d) Thermostatically controlled water bath.
- Q.2**
- (a) **Anomalous Reading:** On average the value shown by antibiotic C seems to be an anomalous. More over as for as individual reading is concerned antibiotic B against Replica 5 (R_5) shows an anomalous reading of 2.5.
- (b) **Most Effective Antibiotic:** Antibiotic D is the most effective antibiotic against all Replica of bacteria. Because the zone of inhibition diameter of this antibiotic is larger than any other antibiotics.
Least Effective Antibiotic: Antibiotic C is the least effective antibiotic against all Replica of bacteria. Because the zone of inhibition diameter of this antibiotic is smaller than any other antibiotics.
- (c) **Purpose of control Experiment:** A control in a scientific experiment is something used as a standard for comparison to check the results of an experiment. Controls are important because they provide a baseline for comparison of the dependent variable in the experiment.
- (d) **Bar chart of data:**



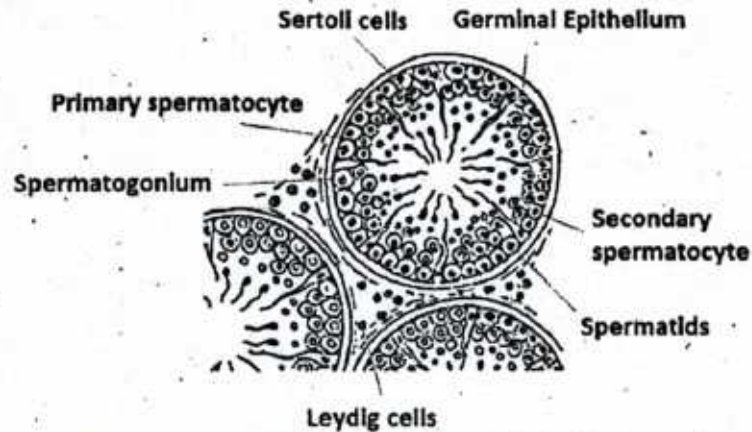
- Q.3 a): Mean ($\bar{x}$): $1701 / 10 = 170.1$ cm
 b): Standard deviation: = 60.76
 c): Standard Error: = 20.25



Calculations and Working			
n=10	Height of students (cm)=x	$x - \bar{x}$	$(x - \bar{x})^2$
A	180	9.9	98.01
B	182	11.9	141.61
C	175	4.9	24.01
D	171	0.9	0.81
E	160	-10.1	102.01
F	172	1.9	3.61
G	170	-0.01	0.01
H	158	-12.1	146.41
I	165	-5.1	26.01
J	168	-2.1	4.41
	$\bar{x} = \frac{\Sigma x}{n} = 1701/10$ Mean = 170.1	$\Sigma (x - \bar{x}) = 0$	$\Sigma (x - \bar{x})^2 = 546.9$
Data arrangement	158, 160, 165, 168, 170, 171, 172, 175, 180, 182		
Median	170.5		
Range	182 - 158 = 24		
Standard deviation (σ or S)	$S = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{546.9}{9}} = 60.76$		
Variance (σ^2)	$\sigma^2 = 3691.77$		
Standard error	Standard error = $\frac{S}{\sqrt{n}} = 20.25$		

- Q.4 (a) 8. Objective Lens 13. Source of illumination
 (b) A. T.S of Monocot Root: Vascular bundles are numerous, radial and arranged in the form of rings and are equal. Pith is large and in the center.
 B. T.S of Dicot Root: Vascular bundles are Few, star shaped and present in the centre. Pith is absent.
- (c) i. Lens: Its primary function is to manipulate light rays to form an image.
 ii. Coarse adjuster (Adjustment screw): Move the lens vertical limb for focusing.
- Q.5 (a) Sikander (Father) : A⁺
 Maria (Mother) : B⁺
 Asad (Child) : B⁺
 Hira (Child) : A⁻
- (b) Sikander (Father) : A⁺ = I^AI^O Dd
 Maria (Mother) : B⁺ = I^BI^O dd
 Asad (Child) : B⁺ = I^BI^O Dd
 Hira (Child) : A⁻ = I^AI^O dd
- (b) O negative.
 (c) I^Ai as the genotype and A blood type.

PHENOTYPES Father ♂	GENOTYPES Father ♂	PHENOTYPES Mother ♀	GENOTYPES Mother ♀
		I ^B d	I ^O d
A ⁺	I ^A D/d	I ^A I ^B	I ^A I ^O dd Hira
	I ^O D/d	I ^B I ^O Dd Asad	I ^O I ^O

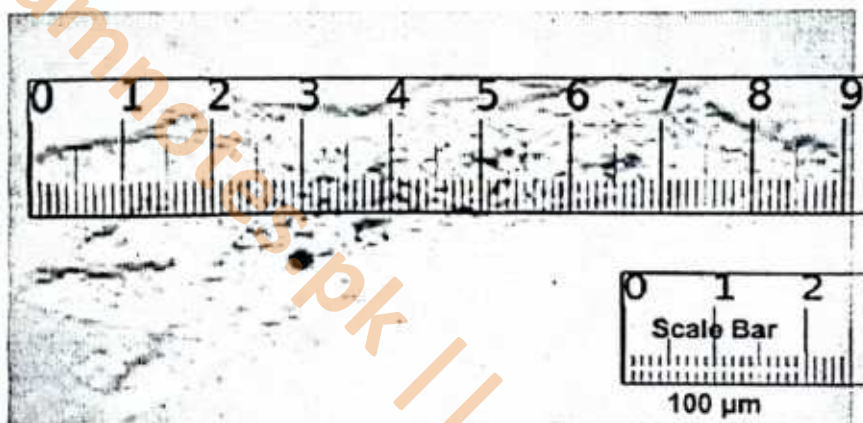
Q.6 (a) T.S of seminiferous tubule

- (b)** To prepare a temporary onion epidermis slide, peel the thin inner layer from an onion, place it flat on a slide with a drop of water or stain (like iodine or safranin), gently lower a coverslip to avoid air bubbles, and blot excess liquid before observing under a microscope.

MODEL SAMPLE PAPER-1**Total Marks: 30****SECTION-A****Time: 2 hours 30 minutes****Note: Attempt all questions and write answers within provided spaces on E-sheet.****SECTION-A (18 Marks)**

Q.1 The given microphotograph is an amoeba. Do as directed as i, ii and iii. Show your calculations. As each question has 2 marks:

- i. Specimen size = mm = X = μm
 ii. Scale Bar Size 100 μm = mm = X = μm
 iii. Specimen Actual Size = X / = μm



Q.2 The **Kirby-Bauer disk diffusion method** is based on the principle of diffusion of antimicrobial agents from impregnated disks into an agar medium that has been inoculated with the microorganism of interest. The following table shows the results 4 antibiotics obtained from disc-diffusion method for a strain of *E. coli*, a facultative parasite.

Antibiotics	Zone of Inhibition (mm)
A	7
B	10
C	18
D	3

i). Which drug above (A, B, C or D) is most effective against this *E. coli* strain & why? (2)

Ans:

ii). Which drug above (A, B, C or D) is Resistant and Sensitive to *E. coli* strain & why? (2)

Ans:

iii). Describe the procedure of Kirby-Bauer disk diffusion method.

(2)

Ans:

Q.3 Leaf surface area is crucial for photosynthesis, transpiration, and overall plant productivity, as it determines how much light a plant can capture and how much carbon dioxide it can take in. A larger surface area generally means a higher rate of photosynthesis. During development of leaves, light intensity plays a great role in increasing surface area of a leaf. A study conducted on the size of leaves of same types of plant grown in sunny and shaded environment. Do leaves grow in full sun have significantly larger width than leaves grown in shade?

Shady (cm)	Sunny (cm)
5	2
12	5
16	15
21	32
28	10

i): Find out the mean and median of the data given.

(2)

Ans:

ii): Calculate the Standard deviation and standard bar error for the provided data.

(2)

Ans:

iii): Plot a bar graph for sunny and shaded leaves showing error bars.

(2)

Ans:

SECTION-B (12 Marks)

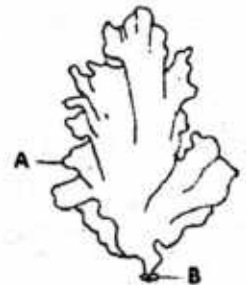
Q.4 (i) Draw a labelled diagram of Euglena.

(2)

(ii) Label the parts A and B; Give the role of part B.

(2)

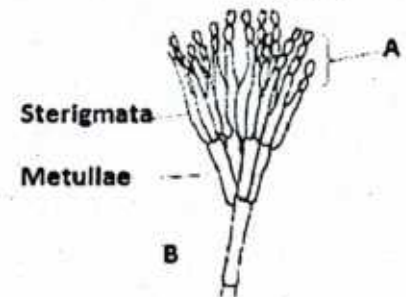
Ans: _____



Q.5 (i) Label the parts A and B; which structure is responsible for production of conidia:

(2)

Ans: _____



(ii) Name and define the phenomenon involved in sexual reproduction in Penicillium (Deuteromycetes)?

(2)

Q.6 Given diagram is of ovarian germ cell.

(i) Label the following parts:

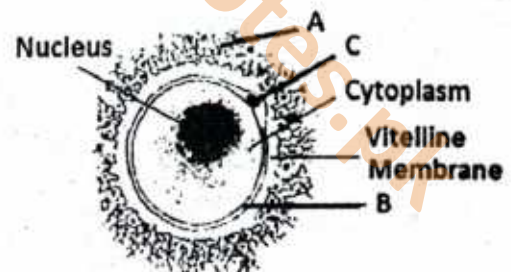
(2)

Ans: A. _____

B. _____

C. _____

Diagram Name _____



(ii) What is the role and composition of labelled part B and C?:

(2)

Ans: _____

Solution:**Model Paper-1**

- Q.1** (i) Specimen size = 90 mm = 90 X 1000 = 90,000 μm
 (ii) Scale Bar Size 100 μm = 0.1 mm = 0.1 X 1000 = 100 μm
 (iii) Specimen Actual Size = 90 mm X 1000 / 200 μm = 450 μm
- Q.2** (i) Antibiotic C is most effective against this strain of E.coli. Because it shows a large zone of inhibition of 18 mm.
 (ii) Sensitive or Susceptible (S): Drug C is the susceptible one because it shows a large zone of inhibition of 18 mm. While
 Resistant (R): Drug D is the resistant one because it shows a very small zone of inhibition of 3 mm only.
 (iii) The method consists of placing paper disks saturated with antimicrobial agents (antibiotics etc) on a lawn of bacteria seeded on the surface of an agar medium, incubating the plate overnight, and measuring the presence or absence of a zone of inhibition around the disks indicating bacterial growth suppression, which is then interpreted as Susceptible, Intermediate, or Resistant using standardized charts.

Q.3 Calculations:

Shady Leaves				Sunny Leaves		
n	Shady (cm)=x	$x - \bar{x}$	$(x - \bar{x})^2$	Sunny (cm)=x	$x - \bar{x}$	$(x - \bar{x})^2$
1	5	- 11.4	129.96	2	-10.8	16.64
2	12	- 4.4	19.36	5	-7.8	60.84
3	16	- 0.4	0.16	15	2.2	4.84
4	21	4.6	21.16	32	19.2	368.64
5	28	11.6	134.56	10	-2.8	7.84
$\bar{x} = \frac{\sum x}{n} = \frac{82}{5} = 16.4$		$\sum (x - \bar{x}) = 0$	$\sum (x - \bar{x})^2 = 305.2$	$\bar{x} = \frac{\sum x}{n} = \frac{64}{5} = 12.8$		$\sum (x - \bar{x})^2 = 558.8$
Standard deviation (σ or S) $S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{305.2}{4}} = 8.73$				Standard deviation (σ or S) $S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{558.8}{4}} = 11.82$		
Standard error = $\frac{S}{\sqrt{n}} = 3.90$				Standard error = $\frac{S}{\sqrt{n}} = 5.29$		
Standard Error Mean = +/- SEM = $3.90 \times 2 = 7.8$				Standard Error Mean = +/- SEM = $5.29 \times 2 = 10.58$		

i): **Mean:** $\bar{x}$ = Sum of all values divided by the count. $\frac{\sum x}{n}$

Mean for shady leaves = $\bar{x} = 16.4$

Mean for sunny leaves = $\bar{x} = 12.8$

Median:

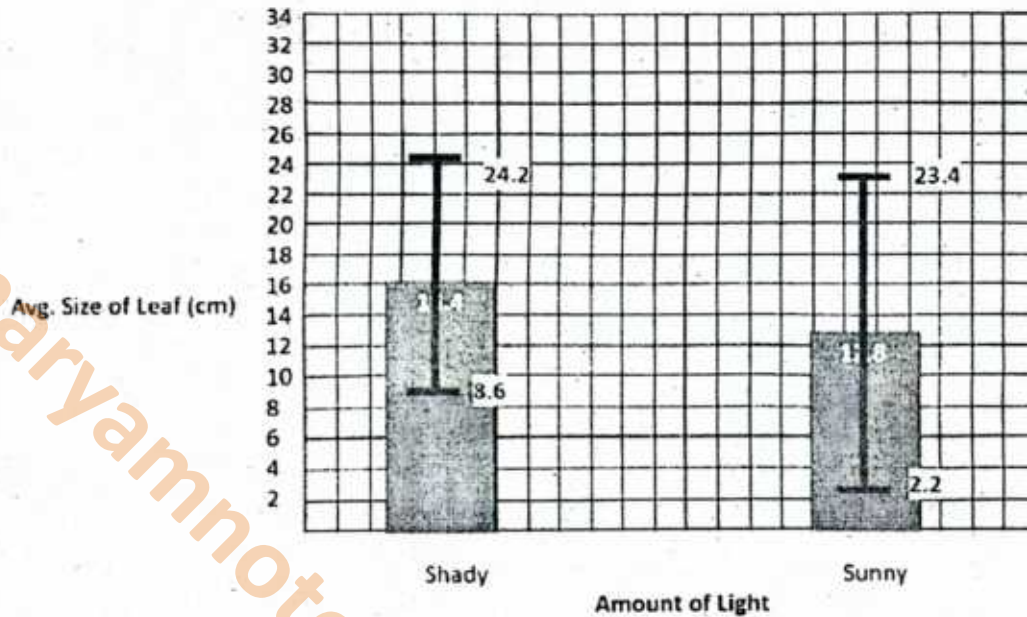
Median for shady leaves = $\bar{x} = 16$

Median for sunny leaves = $\bar{x} = 15$

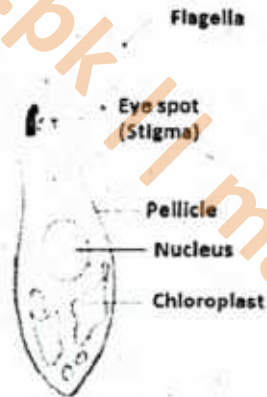
ii): Standard deviation for Shady Leaves = 8.73
 Standard bar error for Shady Leaves = 3.90

Standard deviation for Sunny Leaves = 11.82
 Standard bar error for Sunny Leaves = 5.29

iii):



Q.4 (I) Labelled diagram of Euglena:



- (ii) A. Thallus B. Holdfast
Function: Holdfast is involved in attachment/anchorage.

Q.5 (i) A. Conidia B. Conidiophore
Sterigmata are responsible for Conidia production.

- (ii) Parasexuality: Parasexuality involves the Formation of heterokaryotic mycelium, Nuclear fusions and multiplication of the diploid nuclei, Mitotic crossing over during division of the diploid cells, Sorting out of the diploid strains.

Q.6 (i) A. Corona radiata, B. Zona pellucida, C. Polar body
Name of the diagram. Secondary oocyte.

- (ii) B. **Zona pellucida (ZP)** is a highly organized extracellular coat that surrounds all mammalian eggs. ZP is composed of glycoproteins that are synthesized, secreted, and assembled into a ZP exclusively by growing oocytes.

C. **Polar body:** As primary oocyte divides, it gives rise to 2 cells. One larger cell is secondary oocyte and the smaller cell is called the first **polar body** that may or may not complete meiosis and produce second polar bodies; in either case, it eventually disintegrates.

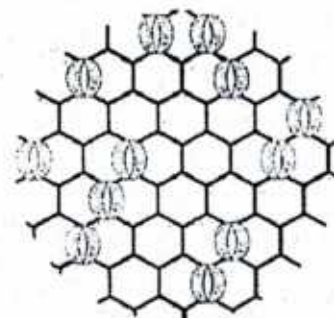
MODEL SAMPLE PAPER-2**Total Marks: 30****SECTION-A****Time: 2 hours 30 minutes****Note: Attempt all questions and write answers within provided spaces on E-sheet.****SECTION-A (18 Marks)**

- Q.1** Scientists use sampling and counting techniques to investigate the distribution of *stomata* on leaves. They count stomata to investigate their numbers, density and distribution on upper and lower surfaces:

In the illustration, the diameter of the field of view of the microscope is 0.40 mm.

- (a) Calculate its area: (1)

Ans:



0.40 mm

Diameter of Field of view of Microscope

- (b) What would be the density of stomata over 1 mm^2 based on this single count: (1)

Ans:

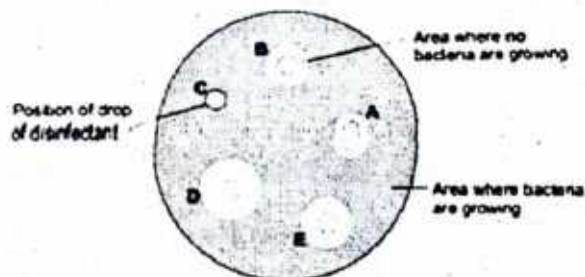
- (c) Using the same microscope, what is the density of stomata per mm^2 based on the following counts? 24 23 22 27 28 25 26 24 26 25. (2)

Ans:

- (d) What is the importance of studying density of stomata? What does it depicts? (2)

Ans:

- Q.2** A student is given a tube containing cultured bacteria of one type only. He grew bacteria on agar on petridish. Then He added drop of each antibiotics A, B, C, D and E. After 3 days he found the results as shown in the figure:



(a) Which antibiotic shows susceptibility rate:

(1)

Ans: _____

(b) Which antibiotic shows resistance rate (R): (1)

Ans: _____

(c) Calculate the inhibition/clear zone area an diameter and fill in the table:

(3)

Ans:

Antibiotics	Diameter of clear zone	Area of clear zone
A		
B		
C		
D		
E		

(d) How the student will prepare an uncontaminated bacterial culture?

(1)

Ans: _____

Q.3 Consider a data for 50 student heights with the following class intervals:

150-155 (f=5), 155-160 (f=10), 160-165 (f=15), 165-170 (f=12), 170-175 (f=8)

a): Find out the mean of the data given.

(1)

Ans: _____

b): Calculate the mode for the provided data.

(1)

Ans: _____

c): Calculate the median for the provided data.

(2)

Ans: _____

d): Calculate the standard deviation and variance for the provided data.

(2)

Ans: _____

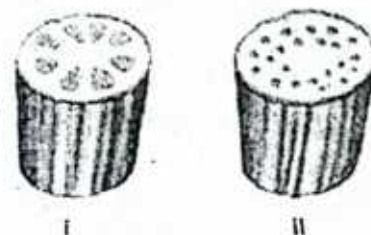
SECTION-B (12 Marks)

Q.4 Given below is Transverse sections of plant organs showing vascular bundles:

(a) Identify the figure i and ii.

(1)

Ans: _____



(b) Derive 2 differences from the given diagrams I and ii.

(2)

Ans: _____

(c) Given in the figure is single lens simple dissecting microscope. Label the part i and ii. Give their relative functions

(1)

Ans: _____

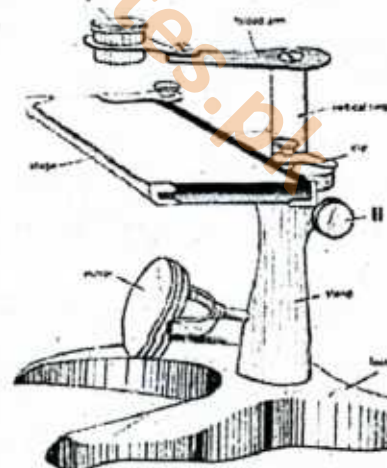


Figure: simple single lens dissecting microscope

Q.5 The ABO blood group is determined by the presence or absence of specific antigens on red blood cells, while the Rh factor is determined by the presence of the Rh(D) antigen. The inheritance of these blood groups follows specific Mendelian patterns, with co-dominance and dominant-recessive relationships:

- (a) Plasma of a person has both Anti-A and Anti-B antibodies. What could be the possible blood group of that person: (1)

Ans: _____

- (b) A person with unknown blood group got seriously injured and need immediate blood transfusion. His friend with known blood group donates blood without delay. What would be the blood group of his friend? (1)

Ans: _____

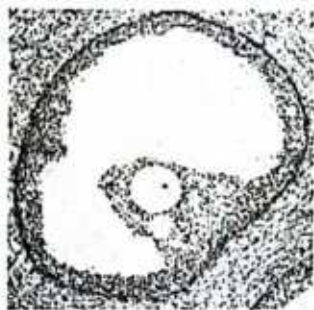
- (c) A woman is married for the second time. Her first husband was ABO blood type A, and her child by that marriage was type O. Her new husband is type B and their child is type AB. What is the woman's ABO genotype and blood type? (2)

Ans: _____

Q.6

- (a) Identify the following figure and draw its line diagram: (2)

Ans:



- (b) Explain how to prepare temporary slide of onion epidermis to observe under light microscope: (2)

Ans: _____

Solution:**Model Paper-2**

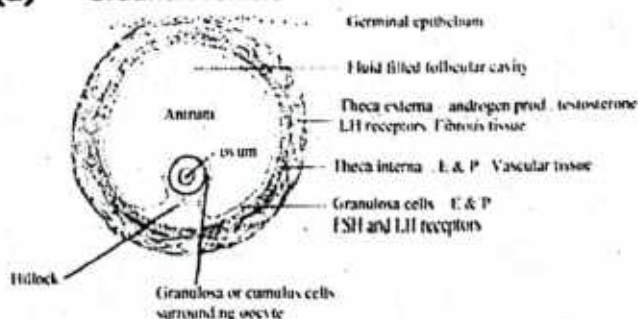
- Q.1** (a) Its area can be calculated using formula πr^2
 $A = \pi r^2 = 3.14 \times 0.20 \times 0.20 = 0.13 \text{ mm}^2$
- (b) The number of stomata in the field of view is 12.
 The area of the field of view is 0.13 mm^2 .
 Therefore, based on this single count, the density of stomata over 1 mm^2 is:
 $12 \times 100 / 13 = 92 \text{ stomata/mm}^2$.
- (c) 192 stomata/mm^2 .
- (d) Stomatal density (number of pores per leaf area) is crucial because it dictates a plant's gas exchange (CO_2 in, O_2 /water out), directly impacting photosynthesis, growth, and water use efficiency.

- Q.2** (a) D
 (b) C
 (c)

Antibiotics	Diameter of clear zone	Area of clear zone
A	7 mm	38.46
B	8 mm	50.24
C	4 mm	12.56
D	11 mm	95
E	9 mm	63.6

- (d) To prepare an uncontaminated bacterial culture, a student must use **aseptic techniques**: sterilize all equipment (dishes, loops) with heat/autoclave, work near a Bunsen flame to kill airborne microbes, use a sterile inoculating loop to gently streak the bacteria onto the nutrient agar, seal the lid with tape, and incubate upside down at a cool temp (like 25°C) to prevent contamination and condensation, allowing growth without harmful pathogens.
- Q.3** a): **Mean ($\bar{x}$):** $\Sigma fx / \Sigma f = 8165 / 50 = 163.3 \text{ cm}$
 b): **Mode:** $160 + [(15 - 10) / (30 - 10 - 12)] * 5 = 160 + (5/8)*5 = 160 + 3.125 = 163.125 \text{ cm}$
 c): **Median:** $160 + [(25 - 15) / 15] * 5 = 160 + (10/15)*5 = 160 + 3.33 = 163.33 \text{ cm}$
 d): **S.D** = 11.54 **Variance** = 133.3

- Q.4** (a) i. T.S of dicot stem ii. T.S of monocot stem
 (b) i. T.S of dicot stem: Vascular bundles are Few, arranged in the form of rings and are equal.
 ii. T.S of monocot stem: Vascular bundles are Many, scattered and are smaller in size.
 (c) i. **Lens:** Its primary function is to manipulate light rays to form an image.
 ii. **Coarse adjuster (Adjustment screw):** Move the lens vertical limb for focusing.
- Q.5** (a) O Blood group.
 (b) O negative.
 (c) $I^A i$ as the genotype and A blood type.
- Q.6** (a) Graafian follicle



- (b) To prepare a temporary onion epidermis slide, peel a thin, transparent layer from the inner surface of an onion, place it flat in a drop of water or stain (like iodine/safranin) on a slide, carefully lower a coverslip at an angle to avoid air bubbles, then blot excess liquid and observe under a light microscope, starting with low power.